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A POWERFUL DREDGE EQUIPPED WITH A CABLE STORAGE DRUM.

The extensive harbor improvement works on the Great Lakes which the U. S. Government has been carrying out for several years by contract work under the direction of the U. S. Engineer Corps, has led to the development of many large and powerful dredging machines for the rapid, efficient and economical handling of heavy work. Several of these have been described and illustrated in our columns. One of the latest and most powerful of these dredges is the "Majestic," built for use on the improvement of the West Neebish Channel in the St. Mary's River, Michigan. The general contractors for this work are MacArthur Brothers, of Chicago, but the dredge is owned and operated by Edward Brothers, of Sault Ste. Marie, Mich., who are sub-contractors. The machine has a number of points of special interest, but its two prominent features are the following: First, that it is powerful enough to dredge solid beds of soft limestone rock without blasting, and, second, that loss of time and money due to the renewal of worn and broken main cables is greatly reduced by the use of a drum which enables 500 or 1,000 ft. of cable to be held in reserve (sufficient for an entire season), instead of using and renewing a number of cables each of which is of the regular working length. A view of the machine is given in Fig. 1.

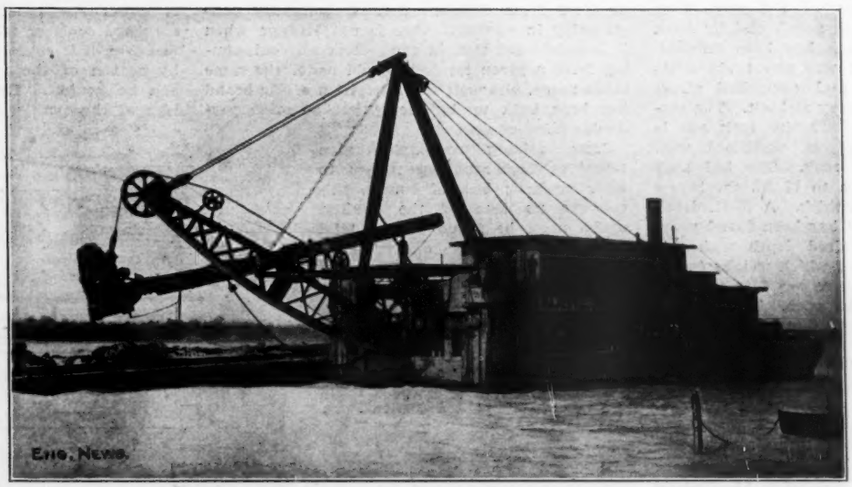

FIG. 1. THE DREDGE "MAJESTIC," IN USE ON THE ST. MARY'S RIVER IMPROVEMENT, MICHIGAN.

The hull is of steel 116 x 40 ft., and 13 ft. deep, with two steel trusses 24 ft. deep extending the entire length. The trusses are built of 12-in. channels and I-beams. The boom is of steel construction, 60 ft. long, stepped into a steel casting at the bow and supported by four cables 2½ ins. diameter leading from the top of a 40-ft. A-frame stepped on top of the anchor slides. Two of those cables take the strain and the other two act as safety cables. The boom is swung by a pair of 2-in. cables on a 24-ft. turntable or swinging circle with arms extending on each side of the boom. These cables are wound on a 40-in. drum, compound geared to a pair of separate engines with cylinders 10 x 14 ins.; these engines are set on the hurricane deck and this arrangement, which is shown in Fig. 2, gives the cables a straight lead from the drum to the swing circle. The dipper handle is 54 ft. long from back of dipper, and weighs 15 tons; with a 5-ft. dipper it will excavate to a depth giving 30 ft. of water. The sheaves for the 2½-in. dipper cable are 8 ft. diameter and are of built-up construction; the hub is of cast iron about 3 ft. long, bushed with bronze, which runs loose on a 9-in. shaft. The spoke section is a steel casting, keyed to the cast iron hub; the rim is also a steel casting and bolted to the spokes.

The dipper is handled by a horizontal engine of 250 HP., capable of exerting, through the gearing, a pull of 200 tons upon the dipper cable. The engine has two cylinders 16 x 20 ins., and the general arrangement of the engine, with the dipper and spud drums, is shown in Fig. 3. As in many large dredges, cables are used instead of chains, and a one-part or direct cable is used to operate the dipper, this being 2½ ins. diameter and running on 8-ft. sheaves so as to give a large radius of bend. The engine drives the differential cable drum, 4 ft. and 6 ft. diameter, through compound gearing, giving 19 revolutions of the engine to effect one revolution of the drum.

The cable drum is of special design, invented and patented by Mr. W. S. Edward, having as its principal feature an extension for about 800 ft. of cable, in addition to the 200 ft. working length, so that a single cable 1,000 ft. long is carried. With the ordinary arrangement the dredge would have a hoisting cable about 180 ft. long, and when this was broken the entire cable would have to be thrown away, as these cables usually break at about 80 ft. from the outer end, and the remainder is then too short for further use. With the Edward storage drum, a cable 1,000 ft. long is used, and when this breaks, only about 80 or 90 ft. are lost, the working length being restored by paying out sufficient cable from the storage part of the drum. The details of this drum and its friction drive are shown in Fig. 4. Cables of this kind cost about $2 per ft., and we are informed that they usually break in less than a month, and sometimes in less than a week, the life averaging probably about three weeks. Taking a season of 30 weeks, this cable storage system would effect a saving of $2,000 in cost of cable alone (for ten 100-ft. lengths of cable thrown away). In addition there would be a saving of about three hours time for each break, or 30 hours for the season. At $30 per hour this would mean $900, and the contractors inform us that in actual use they have found it has saved even more than that, the total saving in cable and time during one season being about $3,000. It is not usual to wait until the cable actually parts, but as the outer end becomes crystallized or weakened by service, the defective portion can be cut off and the cable paid out from the drum to maintain the proper working length.

The drums and gears are all open-hearth steel castings. All friction belts are operated by compressed-air cylinders, the air at 150 lbs. pressure being furnished by two Westinghouse air-pumps arranged tandem. Fig. 5 shows the cylinders and operating mechanism of the friction brake of one of the bow spud hoists.

These bow spuds are of great size, 43 ins. square and 52 ft. long. Each is composed of four 22-in. sticks dressed on all sides to 21½ ins.; these are fitted into a cast steel shoe at the bottom and bolted together for 8 ft. from the bottom with 24 bolts 1¼ ins. in diameter. There are no bolts above these, but at the top the sticks are held together by an iron band ⅝ x 10 ins., so that the individual sticks have a certain amount of spring or movement. In the top of the shoe is a 9¼-in. hole for a 9-in. shaft 10 ft. long, which is secured to the spud foot by six 2-in. and 2½-in. staples with jam nuts on the ends. The spud foot is of timbers 16 ins. square, bolted together with eight 2-in. bolts 10 ft. long, the size of the foot being 10 x 12 ft. The purpose of this is to prevent the spuds from sinking into the bottom when the dredge is lifted up on the spuds, when working in soft material. The dredge can be lifted about 2 ft. above its floating position, and this is accomplished by means of a 2-in. cable running over the top of each spud on a sheave and fastened to the spud slide. The great weight will then force the spuds from 2 to 6 ft. into the bottom, but the broad feet then keep the dredge steady while in operation. The spud and foot are also raised by means of a 2-in. cable running over a sheave which is fastened to the cast steel shoe and is operated by a cable and a hoisting drum driven from the main engine through a friction

band and drum, as shown in the general plan, Fig. 3. The hoisting drum is controlled by the friction band brake shown in Fig. 5, and Fig. 6 shows one of the friction drives from the main engine to the spud hoist. The stern spud is a single 28-in. timber, 55 ft. long, operated by a rack and pinion, as shown in Fig. 7. The spud slides in a heavy fixed shoe, which carries the pinion on the front face and two bearing rollers

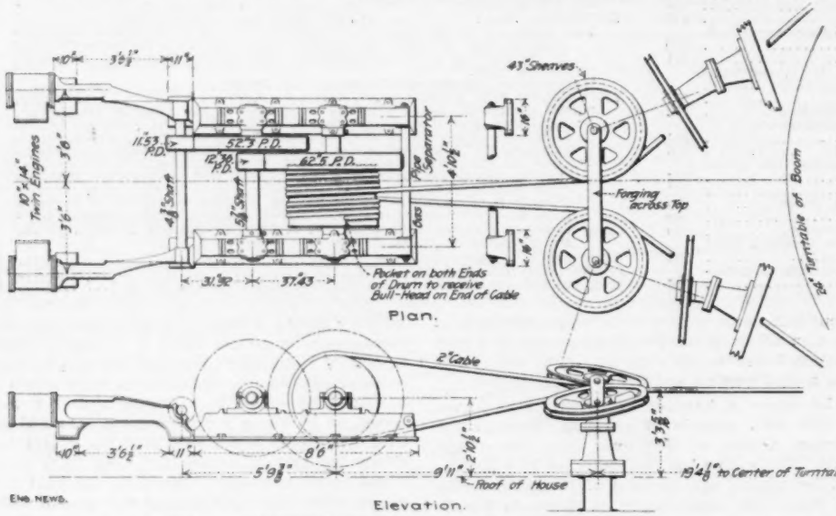

FIG. 2. SWINGING ENGINE OF THE "MAJESTIC."

at the rear face of the spud. The pinion is compound geared, and driven by a chain of forged steel links and roller pins from a separate engine placed below the deck, the chain passing through this deck to the counter shaft of the pinion gear.

This dredge was built to excavate the approaches to the rock cut of the new West Neebish Channel, as already noted, and its work on the Hay Lake approach has been finished. This portion of the work was about six miles long and 300 ft. wide, and comprised about 6,000,000 cu. yds. of sand, clay and silt. The material in the approaches and the rock cut is mostly boulders and hardpan, underlaid with limestone, shale and bed rock. The bed rock varies in depth from 6 ins. to 14 ft., the layers being in some places 4 ft. thick. A 25-ft. depth of water is required and it has been found practicable to secure the required depth with this dredge, using a 6-yd. dipper which weighs (without teeth) over 11 tons; there are four teeth on the dipper, weighing 800 lbs. each. The contractors, Edward Brothers, state that they have not had to blast any of this rock as yet, and expect to get through without blasting, as they think they have gone through the heaviest of the rock, and do not expect to find any more 14 ft. thick. It would be difficult to state the working capacity in this rock, as it is overlaid with several feet of boulders and earth, all being dug at the same time, but the capacity is estimated at from 40 to 50 cu. yds. per hour in the rock alone. The capacity in soft material is about 400 to 500 yds. per hour, using an 8-yd. dipper.

The dredge was built to the general designs of its owners, and has proved very satisfactory in operation. The hull and boiler were built by the Manitowoc Dry Dock Co., of Manitowoc, Wis. The boom, A-frame, swinging circle, sheaves and dipper handle were built by the Bucyrus Co., of South Milwaukee, Wis. The three sets of engines, with drums and gearing, were built by the Jackson & Church Co., of Saginaw, Mich., which company controls the patents for the Edward cable-storage drum, above described.

NEW MILEAGE added to the Atchison, Topeka & Santa Fe Railway system during the calendar year 1906 amounted to 626.7 miles, of which 501.5 miles were built as additions to the present lines and 125.2 miles acquired by purchase. According to Poor's Manual, the total mileage operated and controlled by the System during the fiscal year ending June 30, 1905, was 9,303.9 miles.

TESTING AND PURCHASING COAL FOR STEAM PLANTS.

By A. O. DOANE.*

There is a growing tendency among large consumers of coal to adopt more scientific methods, when buying, instead of the usual custom of ordering by the trade name or brand. If one could be sure of obtaining the kind of coal desired by ordering by name, there would be but little inducement to adopt any other method, but, unfortunately, this is not the case. If Georges Creek, New River, or other standard variety is specified, it will probably be found that different shipments of the same brand, especially if obtained from different dealers, will vary considerably in quality. This is not strange when it is considered that in some cases all coal coming from a given locality is sold under the same trade name, although the reputation of the brand has been built up by the output of some particular mine or vein.

Some mining companies give fancy or high-sounding names to their product; but, of course, this conveys no idea of the quality, which must be found out by trial by referring to some one using it, or by accepting the analysis of some chemist who has tested it either for the dealer or consumer.

The test by noting the evaporation during a trial run in the boiler plant is perhaps the most satisfactory method, if there are the necessary facilities at hand in the way of correct boiler feed meters, thermometers, gages, etc.; if the conditions are uniform when the comparative tests of different coals are made; and last, but not least, if the results are intelligently interpreted. It is often impracticable to make this test on account of lack of time or because trial shipments of the required size cannot be readily obtained.

Published analyses of reports of chemists' tests obtained from dealers are as a rule of but little value as an aid in buying unless the history of the sample on which the tests were made is known. It is a common practice for the miners or agents for a brand of coal to take a small and very carefully selected sample to some well-known chemist and obtain a report from him, which is published to show the high quality of their product. As it is possible to select from a pretty poor lot of coal a sample which will give good results when tested, it will be seen that this method is apt to be misleading.

If an analysis is desired by the purchaser, a better way is to have a sample taken from a cargo, or from the storage bins of some party who is using the coal, by the chemist or by some representative of the purchaser who understands sampling coal. In this way a much better idea of the quality can be obtained than by the test of a small sample which may or may not be representative of the lot from which it was taken.

Some buyers always insist on having the same kind of coal, as it has given them good satisfaction and they hesitate to order another kind with which they are unfamiliar. As the standard brands of coal generally command considerably better prices than varieties which are not so well known, it is often possible to make a substantial saving by purchasing a coal which, perhaps by reason of coming from a recently opened vein, has its reputation still to make, but is either the equal in calorific power to the standard coals or will prove more economical in use even if it contains less heat units per pound by reason of the moderate price for which it can be bought. By proper tests a very good idea of the quality of coal may be obtained, so

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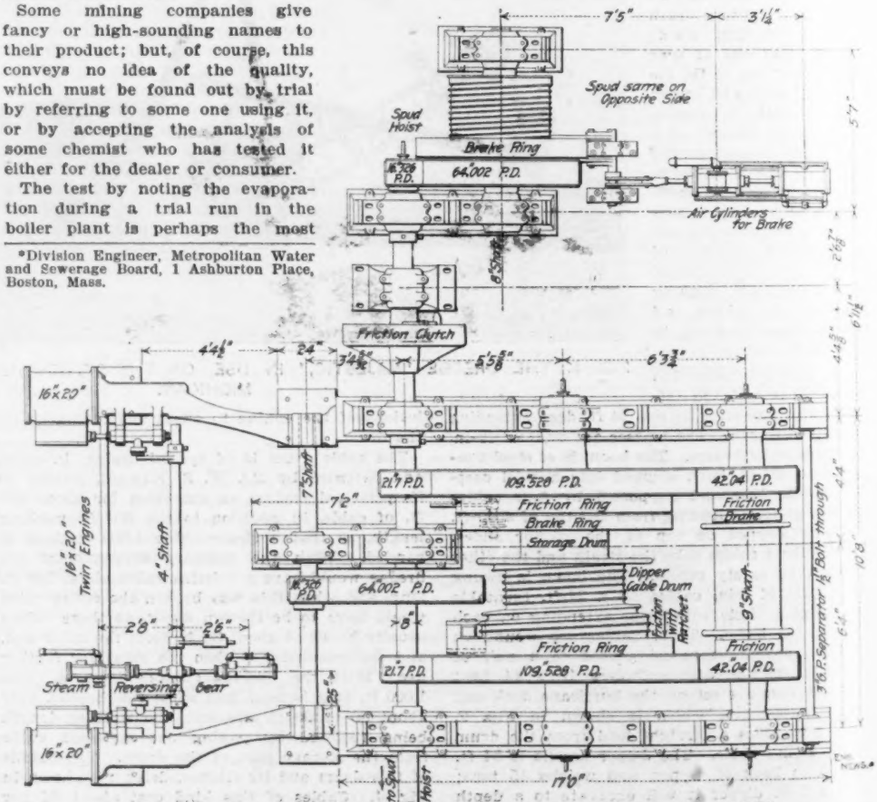

FIG. 3. PLAN OF MAIN ENGINE, WITH ONE OF THE SPUD HOISTS.

that the risk of getting an unsatisfactory lot of fuel is reduced to a minimum.

In the case of many large corporations, the coal is bought by the purchasing agents, who are very apt to consider price as the only criterion by which to purchase. By this method the plants are supplied with a great variety of

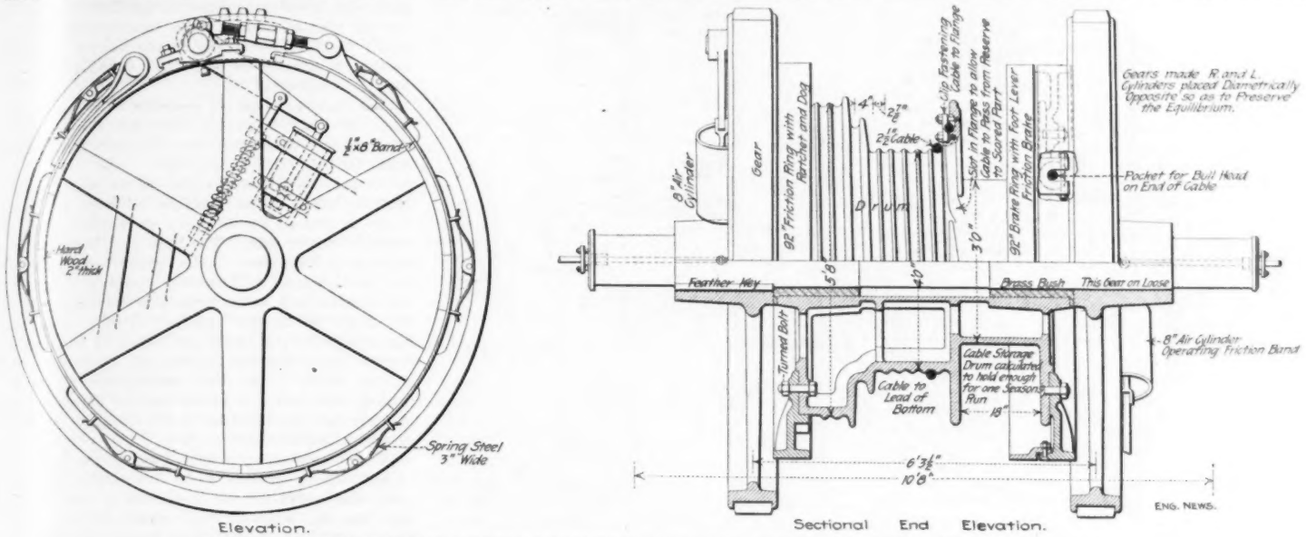
½"x6" Band
Hard Wood 2" thick
Spring Steel 3" Wide
Elevation.
8" Air Cylinder
Gear
92" Friction Ring with Ratchet and Dog
Drum
2½" Cable
Slot in Flange to allow Cable to Pass from Reserve to Stored Part
92" Brake Ring with Foot Lever Friction Brake
Gears made R and L. Cylinders placed Diametrically Opposite so as to Preserve the Equilibrium.
Pocket for Bull Head on End of Cable
30"
Feather Key
5'8"
40"
Brass Bush
This Gear on Loose
Turned Bolt
Cable Storage Drum calculated to hold enough for one Season's Run
Cable to Lead of Bottom
18"
8" Air Cylinder Operating Friction Band
6'3⅛"
10'8"
Sectional End Elevation.
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FIG. 4. SECTION THROUGH DRUM OF MAIN ENGINE; AND ELEVATION OF FRICTION DRIVE.

coals, mostly bad, and as a cheap coal is very often anything but economical, much money is wasted and the power station force is unjustly blamed for not getting good results from the plant. It sometimes happens, especially during periods of labor disturbances at the mines, that railroad companies and other large consumers of coal are unable to obtain enough of the better grade of coal and are practically forced to take inferior kinds in order to keep the plant in operation. In cases like this, it is, of course, impracticable to attempt to hold dealers to rigid specifications.

A point which is often overlooked is the suitability of a given coal to the plant in which it is to be used. The type of boiler and furnace has much to do with this; for instance, in vertical boilers a coal containing a large amount of volatile matter will not give as good results as a semi-bituminous grade carrying 20% or less of volatile matter.

The fireman is also an important factor, as he may get used to firing one kind of coal so as to produce good results, but be unable, either through ignorance or indifference, to handle another coal which requires a different method of firing so as to obtain the evaporation of which the coal is really capable. This question of the efficiency of firemen is a very important one. Many managers seem to act on the principle that any one who has the requisite muscle and is willing to work for low wages will do, while the fact is that the fireman has it in his power to either waste or save a large amount of money for his employer. It would seem that some system which would offer inducements for good work in the fire-room might result in important saving in the fuel expenses.

In testing coal, one of the most important points is the sampling. This must be done in such a way that the small quantity used in the test shall be truly representative of the large body of coal from which it is taken. In order to obtain the best results, shovels full should be taken systematically at many points on the pile or car-load, or a small amount may be taken from the tubs or conveyors at intervals, as the coal is being unloaded. The amount of coal taken in this way should be proportional to the size of the pile to be tested, but should never be less than one bushel. Spread the sample out on a clean, smooth surface, and break all lumps larger than 2 ins. in diameter, mix well with a shovel and make a mound; flatten this down and divide into four parts, rejecting the opposite quarters; break the coal still finer and continue mixing, breaking lumps, and quartering, until about one quart is left. Place this in a glass preserve jar or metal box with tight-fitting cover until ready to test. Then grind the coal finer by means of a coffee mill or mortar and pestle, mix well, take out small portions, and pulverize them for use in the various tests.

The fuel value of the sample is usually determined either by calculation from the results of an ultimate chemical analysis or by burning the sample in some form of calorimeter. The latter method gives the best results, if the apparatus employed is properly designed and constructed, as well as skilfully handled. In the chemical analysis of coal, the determinations usually made are: moisture, coke, volatile matter, carbon, hydrogen, nitrogen, sulphur, oxygen and ash.

The accurate determination of moisture in coal is a very difficult operation, since if the sample is heated sufficiently to drive off all the water some of the hydrocarbons are also vaporized. It is usually of little value in ascertaining the fuel value of coal as delivered to the consumer, as the effect of weather conditions, etc., causes marked variations in the moisture in the same grade of coal.

The test for volatile matter and coke is also difficult to conduct with accuracy, as there is no very definite end point. The coal is heated in a platinum crucible over a Bunsen burner flame of a fixed length for a specified number of minutes. At the end of this time all the volatile matter is supposed to be driven off and the remainder is coke; but a hotter flame or longer heating will produce a marked increase in the percentage of volatile matter found by the test. The determination is of considerable value, as in many instances a coal which is high in volatile matter will give good results when tested in a calorimeter, but will prove unsatisfactory in service, especially if the furnaces and boilers are unsuited to use coal rich in volatile hydrocarbons. This is particularly true of vertical boilers, which give the best results with semi-bituminous coal.

Carbon and hydrogen are determined by burning the coal in a hard glass tube, passing first a stream of air and finally oxygen through the tube; the total carbon in the coal, including that in the volatile hydrocarbons, as well as the coke, is burned to carbon dioxide, which is absorbed in

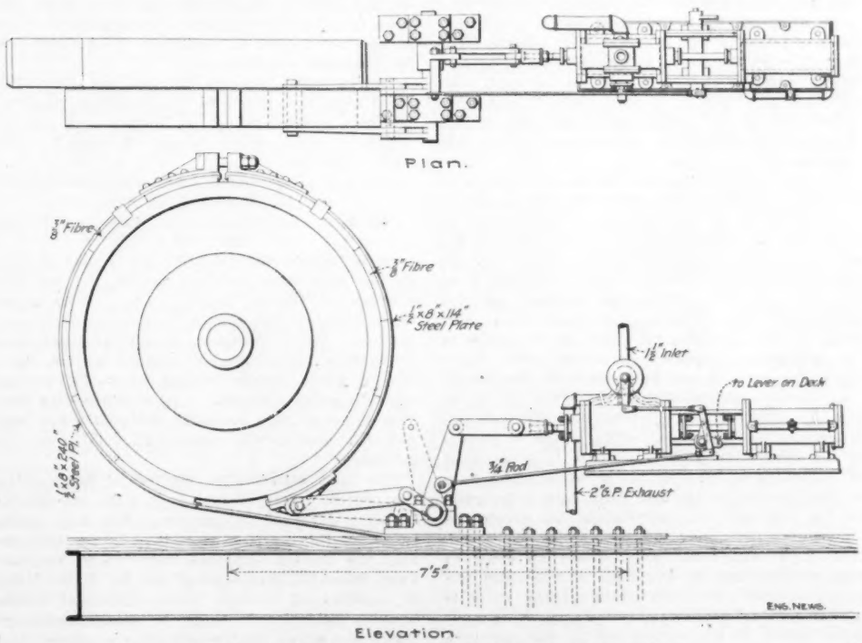


FIG. 5. AIR-OPERATED BRAKE ON BOW SPUD HOIST.

potassium hydrate, the hydrogen burning to water, which is absorbed in calcium chloride.

If it is desired to calculate the heating effect from the results of the ultimate chemical analysis, the percentages of carbon, hydrogen, oxygen and sulphur must be known. The sulphur is, however, of comparatively little importance unless there is an unusual amount present.

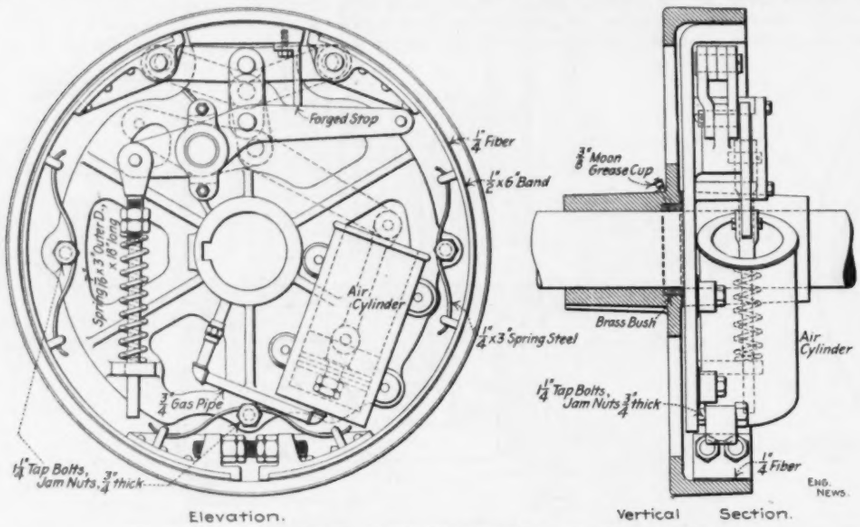


FIG. 6. FRICTION DRIVE FROM MAIN ENGINE TO SPUD HOIST.

Many formulas have been devised to use in calculating the heating effect. The most commonly used formula is the Dulong, or some of its many modifications. The form suggested by the Boiler Committee of the American Society of Mechanical Engineers is calorific power in British thermal units = 146 C + 620 (H — o/8 + 40 S, in which C, H, O and S represent the percentages of carbon, hydrogen, oxygen and sulphur, as determined by an ultimate analysis. The numerical coefficients are based on the heat units produced by the combustion of unit quantities of pure carbon, hydrogen and sulphur. The term H — o/8 is used in accordance with Dulong's theory that the oxygen present in the coal, with sufficient hydrogen to combine with it and form water, should be considered inert. One pound of oxygen requires 1/8 lb. of hydrogen to form this combination.

As very little is known regarding the way in which the elements are actually combined in the coal, which is a complex substance, it will be seen that the assumptions on which the formulas are based are entirely arbitrary and may be quite different from the actual composition of the fuel. In spite of this, the calculations give fairly close results when compared with tests made by the actual combustion of a sample in the calorimeter; usually the error is less than 3%, if the analysis has been correctly performed.

A partial analysis of coal, in which the moisture, volatile matter, fixed carbon and ash are determined, is sometimes made. This is known as the proximate analysis. This is often used by engineers in making boiler tests. The sum of the volatile matter and fixed carbon is taken as the full unit or combustible on which the evaporative efficiency of the boiler is based. Prof. S. W. Parr has pointed out an error in this method, due to the fact that besides the moisture which is estimated by drying there is a considerable percentage of water of composition which is not driven off in the moisture determination, but forms part of the volatile matter, and should be subtracted in order to obtain the true amount of volatile combustible. In the semi-bituminous coals largely used in the eastern part of the country, this water of composition amounts to about 4% of the total constituents of the coal, while in the western coals rich in volatile matter, it may go as high as 14%, and in lignite over 20%. In order to ascertain the amount of this water of composition it is necessary to know the total carbon in the coal. This may be obtained from an ultimate analysis, or by a method devised by Professor Parr, in which the coal is burned in a closed bomb with peroxide of sodium, and the carbon is determined by acidifying a solution of the resulting sodium carbonate and measuring the carbonic acid evolved in a special volumetric apparatus. Both these methods require special and costly apparatus and skilful manipulation. If it is desired to make a correction for this factor in the results of a proximate analysis in cases of boiler tests or where extreme accuracy is not required, it would seem that an arbitrary allowance could be made for the percentage of water of composition, as this seems to be fairly constant for the same class of coal from any given locality.

The proximate analysis is also valuable in identifying a sample, as the characteristics of the different classes of coal are well brought out in this method of testing, and it is often possible to detect and frustrate the attempts of unscrupulous dealers to substitute an inferior coal for the kind specified.

The calorific power of the coal may be calculated from the results of the proximate analysis, but this method is not as accurate as the one which depends on the figures obtained by ultimate analysis.

The formula proposed by Goutal is in English units, $P = \frac{(14{,}650\ C + AM)}{100}$ in which P represents British thermal units per pound of coal; C, the percentage of fixed carbon; M, the percentage of volatile matter; while A is a coefficient which varies with the amount of volatile matter. With ordinary semi-bituminous coal with from 16 to 20% of volatile matter, A = 19,000, gives results within 3 or 4% of the calorific power obtained by the calorimeter test. The value of A is increased for coal below 16% and decreases as the amount of volatile matter increases.

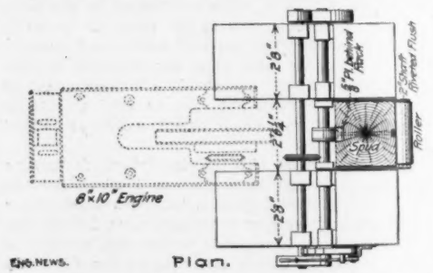
The most satisfactory method of determining the heating effect of fuel is to burn the sample in some form of calorimeter. The best apparatus for this purpose at present in use is probably the Mahler bomb, as improved by the late Prof. Silas W. Holman and Mr. H. J. Williams. It consists of a very strong spherical bomb, heavily gold-plated inside to avoid corrosion. There is a screw cap on top. The powdered coal is compressed into a button shape and placed on a support inside the bomb. Provision is made to ignite the coal electrically. The bomb is then placed in a vessel containing a measured quantity of water and a stirring apparatus is worked until the temperature is constant and uniform. The bomb is filled with oxygen gas under a pressure of about 25 atmospheres. The coal is ignited and burned, the heat being transferred to the surrounding water, from the rise in temperature of which the heating effect is calculated. This work requires considerable skill and care, and several corrections must be applied in order to get accurate results. The apparatus is also very costly.

Prof. S. W. Parr, of the University of Illinois, has devised a calorimeter which seems to be well suited to commercial work. It is of moderate cost and does not require so much skill to operate as the Mahler bomb, while the results are generally within .5% to 1% of the values found by testing a portion of the same sample with the Mahler apparatus.

The Parr calorimeter consists of a small cylinder or bomb in which the coal is oxidized by the use of sodium peroxide and sometimes small amounts of other chemicals. The cylinder is immersed in water in the same way as the Mahler bomb. The mixture of coal and peroxide is ignited by dropping in a small piece of red hot copper wire. The resultant heat of combustion is absorbed in the water and measured by an accurate thermometer reading to .01° F. No oxygen gas is used in this method, and as the pressure in the cylinder is not large, the apparatus is very light, portable and convenient. Careful manipulation is required, as in all work of this kind, if the best results are to be obtained, and while a knowledge of chemistry on the part of the operator is desirable, it is by no means indispensable.

Almost any large corporation would be likely to have in its employ some technically educated man who could devote a portion of his time to coal testing, and if the amount of coal used warranted the expense, could doubtless make substantial savings and obtain better coal.

In purchasing coal, it should be borne in mind that the selling price of coal is not necessarily an indication of its economy in actual use, as this depends upon numerous factors, such as the quality of the coal, the character of the boiler plant, the skill of the firemen, efficiency of the supervision, and kind of work done by the plant. With forced draft and special grates, it is possible to burn the finest grades of anthracite, which are largely reclaimed from the culm piles of the anthracite mines. These are sold at a low price, have rather a large percentage of ash, but have a calorific power which compares favorably



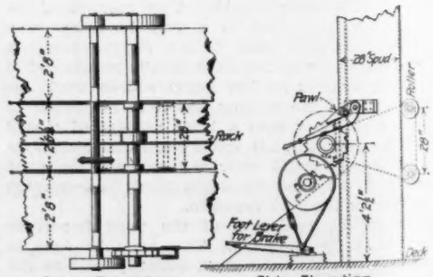


Fig. 7. Operating Gear for Rear Spud.

with some grades of bituminous coals which are sold at a higher price. With natural draft and common grates, it is possible to burn a mixture of bituminous coal and fine anthracite or screenings containing from 33 to 50% of the fine material with good results, effecting a substantial reduction in the fuel bill. This method is especially applicable where the demand for steam is fairly constant, and the fires do not have to be forced.

In regard to the character of the specifications which it would be advisable to use in making

contracts for coal, it is difficult to make any standard form, since the conditions in different parts of the country, as well as in individual cases, are exceedingly variable. They should be so drawn that the buyer will get the grade of coal best suited to his needs at a reasonable price while the interests of the dealer will also be protected.

It is customary to specify the amount of British thermal units per pound which the coal must produce. A reasonable range should be allowed to cover the normal variation in the coal, as mined, but an agreed-upon deduction from the purchase price should be made in case the heat units fall below the minimum established. This reduction may be made proportional to the amount by which the calorific power falls below the standard.

With regard to the percentage of ash allowable, it may be said that in general the heat units will vary inversely with the ash content, but it sometimes happens that a coal with a rather high ash will also show a high B. T. U. The ash is undesirable in other ways by reducing the heat units, as it clogs the fires, makes clinkers, and the handling and disposal is an additional expense, so that it is but fair that a maximum should be established, which should not be exceeded without compensation, even if the B. T. U. are above the minimum. The fusibility of the ash should also be considered. If smokeless combustion is important, if the boiler plant is unsuited to coal high in volatile matter, or if the best grade of steam coal is desired, the percentage of volatile matter allowable should be carefully specified, as the semi-bituminous coals are the best steam producers.

Provision for sampling coal in a manner satisfactory to both parties to the contract should be made and samples should be taken by the purchaser or his representative in all cases.

If there is serious disagreement about the tests or quality of the coal, provision may be made to submit the matter to some chemist to be mutally agreed upon, and to abide by the results of his tests, the expense to be equally divided between the dealer and purchaser.

The question of liability to spontaneous ignition should also be considered. If for any reason it seems desirable to use a coal having a tendency to dangerous heating, it is well to specify that it shall not be freshly mined, shall not contain a large proportion of fine coal, and to take care that it is not stored in too large or deep piles, and that it is watched carefully to detect signs of undue heating.

In conclusion, it may be said that in the majority of cases large consumers of coal would undoubtedly derive great benefit from buying coal in accordance with properly drawn specifications, rigidly enforced, supplemented by frequent tests of the coal as delivered, provided these were carefully made and the results intelligently interpreted.

THE METHODS OF THE STANDARD OIL COMPANY.

The Interstate Commerce Commission on Jan. 28 made a report to Congress upon the transportation of oil and its relation to the monopoly held by the Standard Oil Co. The following excerpts from this report are of especial interest:

At the basis of the monopoly rests the pipe line. With refineries on the Atlantic seaboard, in Pennsylvania, Ohio, Chicago, Kansas City, and at various other points, which are all connected with the principal oil fields and with each other by a network of pipe lines, the Standard may to-day pump oil from a well in Indian Territory to its refinery at Jersey City. The cost of piping a barrel of oil from the Kansas field to the Atlantic seaboard would not be much, if any, above 30 cts. The independent refiner is located usually near the source of the crude supply, but the Standard locates its refineries near the great centers of distribution. The independent refiner in interior Kansas finds it difficult to dispose of his residuum, such as fuel oil, because the railroad rate is almost as much as its value; but the Standard has at the doors of its refinery in Kansas City a market at a favorable price for a large part of this by-product, and this is of itself an enormous advantage.

The refined product can be distributed cheaper and with better facilities from a distributing center like Kansas City than from a noncompetitive point. Possession of the pipe lines enables the Standard to absolutely control the price of crude petroleum and the price which its competitors in a given locality shall pay. It can raise the price in one locality and obtain its own oil from another, and reverse the process when it desires to do so. Whoever controls the avenues of transportation of the raw material or of the refined product can speedily drive his competitors out of existence, and the production and distribution of petroleum is no exception to the rule.

The pipe-line system of the Standard is not a natural, but rather an artificial advantage. Any person with sufficient capital—and the expense is not great—can construct and operate a pipe line. The reason why long pipe lines competing with those of the Standard have not been provided is found in obstacles thrown in the way of such undertakings, having been opposed by the railways, whose right-of-way has generally stood as a Chinese wall against all attempts to extend pipe lines. From the railway standpoint, the pipe line takes the traffic which the railway would otherwise obtain; but in cases brought to the attention of the Commission every facility has been extended to the Standard for the construction of pipe lines, while the railways have generally done all in their power to prevent their construction by competitors of the Standard. The crude oil is generally transported by pipe line and the refined oil by rail.

It is a matter of official record that the Standard achieved victory over all competitors in the '70's and '80's through a system of railway rebates. It accumulated during that period by this illegal means profits estimated at $250,000,000. In recent years it has changed its methods and adopted other plans for obtaining an advantage in railway rates. Some of these are indicated by the Commission as follows:

While the Standard has not received rebates, it has nevertheless enjoyed secret rates possessing all of the elements of illegal rates, and the advantages so obtained over independent shippers have been of very great value to that company.

Numerous instances of discrimination in favor of the Standard resulting from the published railway rates were found. A low rate of 10 cts. per 100 lbs. upon petroleum and its products existed for many years from Neodosha, Kan., where the Standard operated a refinery, to Kansas City. This was for the interest of the Standard; but when the Standard constructed its refinery at Sugar Creek, Kansas City, and connected it by pipe line with the Kansas oil wells, the rail rate was advanced from 10 to 17 cts. per 100 lbs. While the railways insist that this was not done at the instance of the Standard, the significant fact remains in this and many other cases called to the Commission's attention, that the rate was not changed until it came to be for the interest of the Standard that it should be changed, and it was also changed exactly as that company would naturally desire. The increase in the rate also rendered it just so much more difficult for the independent Kansas City operators to compete with the Standard Oil Co., and increased by just that amount its advantage and the price at which it could market its oil.

Formerly through rates were in effect on refined oil from Pennsylvania and Ohio points to territory west of Chicago, but in 1890 the great refineries of the Standard were erected at Whiting, Ind., near Chicago, and thereupon lines west of Chicago declined to join in through rates with lines from the east, and independent refiners were compelled to pay the full locals from the point of shipment to Chicago, plus the full local beyond. This increased the through rates to its competitors and aggravated the advantage which the Standard possessed by reason of its ability to pump its oil to Whiting at a small cost and refine it at that point.

The Commission long ago pointed out that the railway schedules of this country were filled with discriminations of this character in favor of the Standard Oil Company, which could not, as the law then stood, be corrected. The Commission refers to its report or decision in the New York, New Haven & Hartford Railroad case, which involved refusal of that road to join in through rates upon petroleum, as it did upon other commodities, and wherein it was shown that the Standard thereby obtained a monopoly of the territory covered by that railroad system and directly put into its treasury between $200,000 and $300,000 per year.

HOW THE STANDARD OIL CO. RUINS ITS COMPETITORS.

The ruin of its competitors has been a distinct part of the policy of the Standard Oil Company in the past, systematically and persistently pursued. One method has been the organization of a perfect system of espionage over the shipments of its competitors, resulting in knowledge as to the destination of every car of oil leaving the refinery of an independent. The Standard agent at the destination is held responsible if the independent oil is sold. The testimony shows that the Standard at one time, if it does not now, devoted a fund to the purpose of obtaining this information. It has frequently happened, when the supply of independent oil in a particular territory was low and a shipment was peculiarly necessary, that the shipment has unaccountably gone astray. Information also appears to have been given the Union Tank Line, a creature of the Standard, concerning the whereabouts of its cars, while such information was not furnished to other owners of tank cars. Many roads issued passes on account of the Union Tank Line which were in fact used by selling agents of the Standard. Many local agents of roads have been in the employ of the Standard, and this may account for the unsatisfactory service accorded to independent shippers.

Most roads charge higher rates on oil in tank cars destined to consignees who do not have proper facilities for unloading, such as storage tanks so situated that the oil can be transferred by pipe from the tank car to the storage tank. This has brought about the erection of distribution tanks in all parts of the country. The cost of erecting such a tank is not very great, and the rule would ordinarily impose no hardship; but it is the practice of the Standard, whenever a competitor so erects a tank, to reduce the price of oil in that locality to such a point as to make the business unprofitable to the competitor, while prices were maintained in other localities. Whoever would compete against the Standard must erect these tanks—not at one, but at many points, and this requires large investment. The tanks are necessarily located near the railroad tracks, and there was much complaint that the railroads allowed the Standard to erect its tanks at convenient points on the railroad right-of-way and declined to accord this privilege to independent refiners. The Commission is satisfied that such discrimination has been very generally practiced in the past.

The report shows that at present every considerable railroad in the United States is buying of the Galena Oil Co., one of the Standard companies, most of its lubricating and signal oils, the prices paid for lubricating oil, which is of three grades, being substantially the same to the various roads. The contracts generally contain a guaranty to the road that the cost of lubrication shall not exceed a certain sum per car mile or engine mile, and provide for oil inspectors appointed by the oil company to supervise the use of the oil. The Galena Co. is rarely called upon to pay anything under the guaranty, and the prices obtained by the oil company are extravagantly high. Oils of the same grade could be bought in the open market for about one-half the Galena Co.'s prices. The traffic official of one railroad company is said to have stated that the Standard traffic was many times that of an independent, and that that settled the proposition. Another operating official wanted to contract with an independent concern, but declared the matter off after a conference with his president. Most roads prefer to stand on the guaranty, and no other concern proposes to give such a guaranty.

Some of the methods of competition indulged in by the Standard are as follows:

The Standard has repeatedly, after becoming the owner of a competing company, continued to operate it under the old name, carrying the idea to the public that the company was still independent and competing with the Standard. It has used such purchased or independently organized companies to kill off competitors by such companies reducing prices. The operation of such fake independent concerns has been one of its most effective means of destroying competition. The Standard has habitually reduced the price against its competitor in a particular locality, while maintaining its prices at other places. When competition was destroyed it restored or advanced former prices.

The Standard has sold different grades of oil at different prices from the same barrel. It has paid employees of independent oil companies for information as to the business of those competitors, and has paid employees of industrial companies to secure the adoption of its oil in preference to that of its competitors. Its motto has been the destruction of competition at any cost, and this policy has been pursued without much reference to decency or conscience. It is significant that the larger independent refiners sell the greater part of their product in foreign countries. One independent testified that 75% of his product went abroad, and said that he could compete with the Standard in Germany, where its methods as followed in this country would not be tolerated, but that he could not compete with it here.

Estimates made in the report show a profit by the Standard Oil Company on refined oil from the Sugar Creek refinery at Kansas City of from 5 to 8 cts. per gallon. A much higher profit is indicated for gasoline.

The evidence shows little basis for the contention that the enormous dividends of the Standard Oil Company are the legitimate result of its economies. Except for its pipe lines, the Standard has but little legitimate advantage over the independent refiner. The Standard buys advertising space in many newspapers which it fills, not with advertisements, but with reading matter prepared by agents kept for that purpose and paid for at advertising rates, as ordinary news. The assumption is that this literature furnishes many of the ideas touching the great benefits conferred upon the public by the Standard Oil Company!

More than anything else the pipe line has contributed to the Standard Oil monopoly, and its supremacy must

continue until its rivals enjoy the same transportation facilities. The amended act to regulate commerce makes the existing pipe lines common carriers subject to that act, and the power to prescribe just and reasonable rates, regulations, and practices, after complaint and hearing, is conferred upon the Commission. But the pipe line tariffs filed with the Commission are alleged to be of no actual advantage to the independent operators. The Commission can only act upon these schedules after complaint has been made challenging specific rates, regulations, or practices. Some complaints are now pending. How far the amended act will prove adequate to the correction of such injustice as now exists in respect to this traffic remains to be seen.

FIG. 1. FACTORY FOR THE ARTIFICIAL PRODUCTION OF NITRATES AT NOTODDEN, NORWAY.

THE ARTIFICIAL PRODUCTION OF NITRATES FROM THE ATMOSPHERE.

By J. B. VAN BRUSSEL.*

In round numbers, four-fifths of the air which surrounds the earth is nitrogen. In 1781, Cavendish attempted, by the use of a very high temperature, to cause the oxygen and nitrogen of the air to unite and form nitric oxide gas.

This reaction, which is denoted chemically by the equation $N_2 + O_2 = 2NO$, has been repeated since by many other chemists who have thought of using the principle for the industrial production of nitrates. The realization of their aims and projects has, however, been hampered by two main difficulties. The production of nitric oxide required the high temperature of the electric arc, and a cheap supply of electric power, which was essential to give the process any prospects of financial success, was not until recently available. In the second place, the thermal action which produces the union of the nitrogen and oxygen by sparking is a reversible one, and the same heat energy which produces the nitric oxide causes its dissociation, unless it is speedily removed from the influence of the electric spark.

Since the opening of cheap water-power development, the first of the two difficulties under consideration was no longer existent; the second, however, caused the failure of more than one process. The Bradley and Lovejoy process, for instance, which was developed at Niagara Falls, and which was purchased by the Atmospheric Products Co., who attempted to employ it upon an extended scale of operation, did not achieve financial success and the factory erected at Niagara Falls was obliged to close down early in 1905.

A new process, invented by two Norwegian scientists, Birkeland and Eyde, has since been introduced, and is claimed to be a complete success. While the Bradley and Lovejoy process depended upon the use of point discharges, Messrs. Birkeland and Eyde employ a disk of flame. The disk of flame is the special feature of the new invention, and gives it a much higher efficiency than any other process that preceded it. The disk of flame is produced as follows:

The arc is struck between horizontal electrodes in series with an inductance coil, and the magnetic field is applied by a powerful electromagnet, the poles of which are brought close to the arc, at right angles to the electrodes. The arc is rapidly driven outward, traveling back along the electrodes until it breaks, when a new arc is instantly formed between the tips of the electrodes and is driven outward in its turn, the successive arcs following each other so rapidly that thousands may be formed in a second. In practice, the frequency is a few hundreds per second.

When the arc and the magnet are both fed with direct current, the arc is always deflected to the same side, but when alternating current is used for one and direct current for the other, the deflections are alternately on opposite sides, and the rapid succession of arcs gives the appearance of a disk. As the arc seems to move rather more quickly at the negative end than at the positive, the disk is slightly distorted, giving the appearance shown in Fig. 2. A photograph of an electric disk-flame, which represented about 250 HP., is reproduced in Fig. 3. This is the arrangement generally used by the inventors.

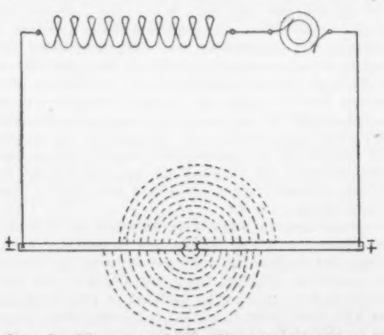


Fig. 2. Diagram of the Electric Disc-Flame.

The furnace or "oven" originally employed is shown in Fig. 4; this diagram gives a vertical section at right angles to the electrodes, but the furnace has since been modified in the light of later experience. Air is forced through the channels AA into a chamber, where it is brought into intimate contact with the electrodes E before passing out by way of the channel C, carrying with it a proportion of oxidized nitrogen. In the larger units first experimented with, from 75 to 200 KW. were used between one pair of electrodes, the arc being struck with alternating current at 500 volts pressure and 50 cycles per second frequency. The electrodes can be made of copper or iron, are easily cooled with air or water, and last several hundred hours.

The Notodden Saltpeter Manufactory at Norway, shown in Fig. 1, employs the Birkeland and Eyde process and has been in constant operation about a year. Three generating units or furnaces (Fig. 5) of 700 HP. each have been erected, and when all are working, about 2,648 cu. ft. of air can be treated per minute. The furnaces burn with an astonishing degree of steadiness, there being only 2 or 3% variation in energy, although the electrodes have no automatic regulation. The furnaces work with a power factor of over 0.7. With a working potential of 5,000 volts, 3,500 volts and more are obtained across the electrodes. The cost of these furnaces, including inductive resistance, is $5,000.

The gases come from the furnaces at a temperature of 600° C. to 700° C. and pass under a steam boiler, the steam of which is employed in the further manufacture of the ultimate product—calcium nitrate. After the gases are discharged from the steam boiler, their temperature is reduced to 200° C., and they are then conducted through a cooling apparatus to be further cooled to about 50° C. The cooler the gases, the more easily are they absorbed by water.

The gas next enters two large oxidation chambers with acid-proof linings. Here the oxidation of the compound formed in the furnaces takes place, nitric oxide becoming nitric peroxide, which is then conducted farther into an absorption system, where the gas is converted into nitric acid. The absorption system consists of two series of stone towers, whose internal dimensions are 6½ × 6½ × 32½ ft. Each series contains five towers, two of granite and two of sandstone, filled with pieces of quartz over which water and the nitric acid formed are made to trickle; the fifth tower in each series is filled with ordinary bricks, over which trickles milk of lime. The milk of lime quickly absorbs the rarefied nitrous gases remaining, and is converted into a compound of calcium nitrate and calcium nitrite.

The first tower yields nitric acid concentrated 50%, the second about 25%, the third 15%, and the fourth 5%. The liquids from the fourth tower are raised by compressed air to the top of the third tower, those from the third to the second, and those from the second to the first, thus gradually increasing their concentration up to 50%, at which density the acid is conducted into a series of open granite tanks where it is temporarily stored.

Some of this acid is employed in the decomposition of the nitrate-nitrite combination obtained from the absorption by milk of lime. By the addition of nitric acid, the nitrous anhydride contained in the nitrite is driven out and carried back to the system of towers. The solution resulting from this, containing pure calcium nitrate, is carried, together with the rest of the stored-up acid, into another series of granite tanks, where this mixture of acid and aceteous calcium nitrate lye, reacting on ordinary limestone, is converted into a solution of neutral calcium nitrate. This neutral lye is carried farther into vaporization chambers of iron, where it is vaporized to a boiling point of 145° C., which corresponds to a concentration of from 70 to 80% of calcium nitrate, containing about 13.5% of nitrogen. This substance is then run into iron

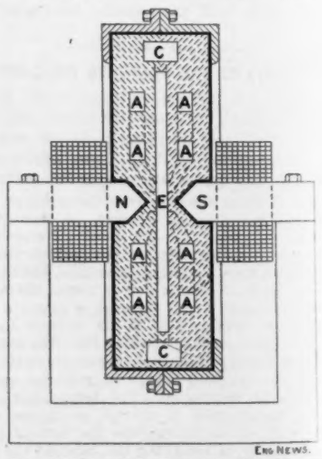


Fig. 4. The Birkeland & Eyde Electric Disc "Oven" or Furnace.

*Brussels, Belgium.

drums having a capacity of about 7 cu. ft., where it congeals, and in that form appears on the market.

It is said that only 5% of the nitrous gases escape absorption by this treatment. Prof. Witt, Director of the Imperial Chemico-Technical Institute, of Berlin, who has personally investigated and reported upon the working of this plant,

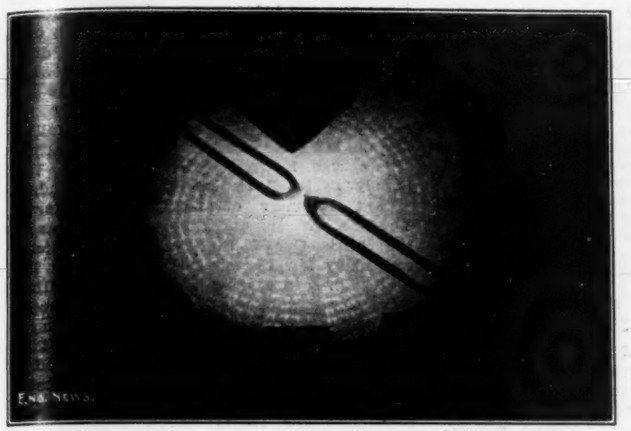


FIG. 3. PHOTOGRAPH OF A 250-HP. ELECTRIC DISC-FLAME USED IN PRACTICE.

calculates that half a ton of 100% nitric acid is produced per KW-yr., and that at Notodden this amount of electric power costs only $3.80. Each of the furnaces described therefore produces the equivalent of 250 tons of 100% nitric acid per year, equivalent to 325 tons of calcium nitrate, or to 337 tons of nitrate of soda per year. The present plant at Notodden is therefore capable of producing nitrates equivalent to 1,000 tons of Chili saltpeter per year.

A company has been formed in Christiania to exploit the Birkeland and Eyde process on a much larger scale at Notodden, and for this purpose a capital of over $1,150,000 has been raised, partly with the aid of German banks.

INDEXING AND FILING MACHINE DRAWINGS.*

By J. J. HARMAN.†

In devising a system for indexing and filing drawings, the requirements peculiar to the particular case under consideration should be analyzed and carefully studied before deciding upon the basis of classification. To illustrate the difference in conditions which may occur, I will briefly outline the conditions as they exist at the drafting room of a large factory, and the Mechanical Engineering Department of the University of Illinois.

The factory is that of a firm manufacturing a line of agricultural implements, such as binders, reapers, headers, mowers, etc. The following were the governing conditions which formed the basis for the system of indexing and filing. The drawings were used continually, and as they were likely to be wanted at any time it was necessary to have a convenient index for quickly locating them. There were large numbers of drawings to be taken care of, and the drawings for any particular machine were so numerous that filing by machines would not have been at all satisfactory.

The condition which formed the basis of the index was the fact that each and every part had a repair list number, and was known by that number rather than by name. The method used was as follows: Each drawing when completed was recorded in the drawing record book, and was given a serial number, thus all possibility of two drawings being marked with the same number or of any drawing ever being lost without the knowledge of the drafting room was prevented. The standard sizes for sheets were 24 × 36 ins., 18 × 24 ins., 12 × 18 ins., 9 × 12 ins., and 8½ × 11 ins. These sizes were designated by the numbers 1 to 5, respectively. Each one had a separate record book, and a separate series of numbers starting from unity.

Drawings were also made in the tool room, so in order to distinguish drafting room from tool room drawings each sheet of the former was marked with the letter D. The number of a drawing consisted of three parts; the number designating the size of the sheet, the letter designating the source of the drawing, and the serial number: thus, 3 D 578 signified that the sheet was 12 × 18 ins., was made and on file in the drafting room, and was the 578th sheet of that size to be recorded. This number was placed in the margin of the drawing outside of the border line, in both the lower right-hand and the upper left-hand corner. The number in the upper left-hand corner was inverted, so that should the sheet by any chance become inverted in the drawer the number would still be found at the lower right-hand corner of the pile of drawings. The drawings were filed in drawers slightly larger than the sheets and the order of filing was that of the serial numbers running up from the bottom of the drawer to the top.

The method of indexing was by a card system based on the repair list numbers of the parts. These cards were standard 3 × 5-in. cards, and as they were arranged in the order of the repair list numbers they were easily located in the index. The body of the card contained the name of the part and the number of the sheet on which it was to be found.

Another rather serious problem which had to be dealt with in this particular case was the care of blue prints. A supply of blue prints was kept constantly on hand, because the shop foremen were likely to come in at any time for a print of a certain part, and they always wanted it at once. When they were through with it they would return it to the drafting room, where the prints were kept on file in precisely the same way as the drawings. It was necessary also to keep a complete record of all blue prints from the time they were made until they were destroyed, on account of the fact that changes in drawings were being made constantly, and whenever this occurred all the blue prints had to be called in and either destroyed or changed to correspond to the new drawing. This record was kept on 3 × 5-in. cards. A record card was made out for each sheet, and by referring to it, it could be determined at any time just how many blue prints were out, and where they were located.

The conditions existing and the system in use in the Mechanical Engineering Department of the University of Illinois are entirely different from the above. In the first place, the class of work there is much wider in scope, and then the repair list numbers which were so convenient for indexing in the former case are in this case lacking. The machine design department, which is the main source of drawings, does not keep blue prints of the tracings on file, but simply furnishes them from the originals when required. This department does have on file, however, a large number of prints which have been obtained from manufacturers for the aid of students in design work.

The tracings made by the department are naturally much more important than the prints, and consequently a more detailed system of caring for them is used. The card system is used for the record instead of a record book. The record number is made up of two parts, a machine or general number and a sheet number. The machine numbers form the single consecutive series, and the sheet numbers form sub-series for each machine.

With this system drawings may be made and filed in the department where they are to be used if it is so desired. The record cards are so filled out that they serve as a record of the pattern numbers as well as the sheet numbers. Thus, the record number of a drawing is 23.3, 23 being the machine number and 3 the sheet number. Likewise the pattern number is 23.1, 23 being the machine number and 1 the number of the part.

In the designation 1 B 5, the 1 signifies the department where the drawing was made and to which it belongs, while B signifies the number of the sheet, and 5 signifies the drawer of the filing cabinet in which the drawing is kept. The drawings are filed in the order of the machine and sheet numbers. Should more than one record card be required for listing the parts contained on a single sheet, the succeeding cards are filled out in exactly the same way as the first, but are on blue paper instead of white.

The method of placing the numbers on a sheet is to draw a ring with a black strip across it. The black strip leaves a white space on the blue print, upon which the owner of the print may write his name or the number of his department.

The index is kept on cards 3 × 5 ins. and is based on the Dewey decimal classification. The Department of Mechanical Engineering at the University of Illinois has prepared quite an elaborate extension of the number 621, which represents Mechanical Engineering, and by the aid of this extension it is possible to separate the different classes of machinery into rather small divisions. This extension is used quite generally in the Mechanical Engineering Department for indexing all kinds of matter, and has proved very satisfactory.

In the drawing index a card is made out for each machine, and cross reference cards are made out for such parts as have a different Dewey number from that of the machine itself. This method of indexing decreases materially the volume of the index below that which would be required were a card filled out for each and every part. It is also fully as efficient in locating the drawings, because after the machine number is determined, the drawing of any particular part may be found from the bill of material or from the record cards. The bill of material is always the first sheet. Parts are numbered in the order of their size, and cast parts are detailed first, then forged parts, and lastly parts made of wood, fiber, etc.

Blue prints coming from outside the department are

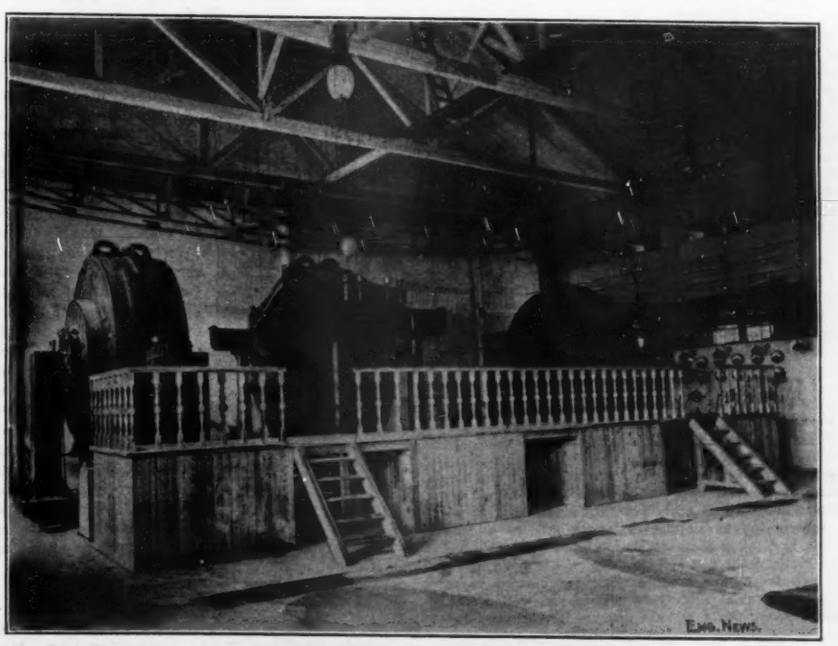


FIG. 5. INTERIOR OF THE NOTODDEN FACTORY, SHOWING THE THREE FURNACES IN OPERATION.

*Abstract of a paper on "Making, Indexing and Filing Machine Drawings," presented at the annual meeting of the Illinois Society of Engineers and Surveyors, at Peoria, Ill., Jan. 23, 25, 1907.

†Instructor in Machine Design, University of Illinois, Urbana, Ill.

marked by pasting a white 1¼-in. circular tag in the lower right-hand corner, upon which the department and Dewey number are placed. The blue prints are then filed away in drawers by the Dewey numbers irrespective of size of sheets. No index is necessary.

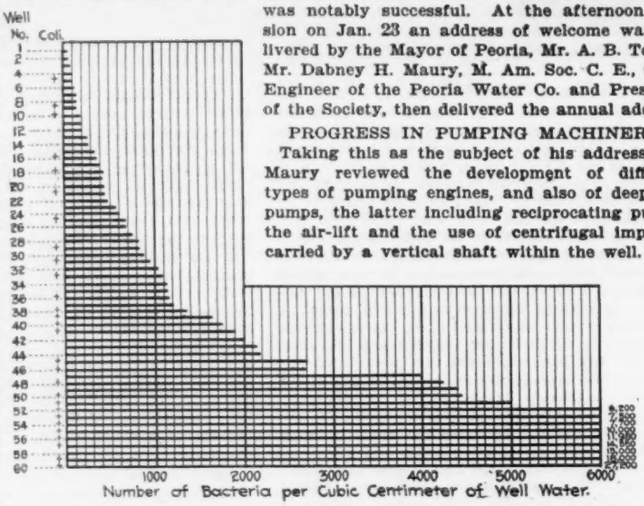
This system is not as convenient as the other for locating a particular drawing and does not provide against loss of a sheet. However, the labor of indexing and filing is considerably reduced and all of the drawings of a certain class of machinery are kept together, so it serves its purpose very well.

BACTERIA OF THE DAIRY WELLS IN THE VICINITY OF WASHINGTON, D. C., AND THEIR POSSIBLE RELATION TO TYPHOID FEVER AT WASHINGTON.*

By KARL F. KELLERMAN and T. D. BECKWITH.†

During the past few months the city of Washington has been a place of unusual interest to the sanitarian, and many articles and discussions have been published dealing with the possible causes of the high typhoid rate, both including and excluding the filtered water supply. It perhaps may now be considered a matter of history that the Potomac water, after having passed the filtration plant, is considered safe. Various other possible causes of the prevalence of typhoid fever are being investigated and eventually no doubt all the facts in the case will be known.

Naturally, one of the first objects of suspicion after the water supply is eliminated is the milk supply. The investigation of diseases caused by the milk supply is an exceedingly difficult undertaking for the city of Washington. There are approximately 900 dairy farms daily supplying milk to Washingtonians; and the Health Department of the District of Columbia, owing to the lack of funds and small staff, is unable to rigidly inspect and supervise the farms, and in many cases is doubtless unable to trace the milk supply of typhoid fever patients. Because of the apparent need for immediate action, the Secretary of Agriculture agreed to assist in furthering the bacteriological work, especially, and with the Health Officer of the District arrangements were made for a somewhat general sanitary survey of the dairy farms.



BACTERIAL CONTENTS OF DAIRY WATER SUPPLIES IN THE VICINITY OF WASHINGTON, D. C.
(Laboratory of Soil Bacteriology and Water Purification Investigations, U. S. Department of Agriculture.)

Only that part of the work which bears directly upon the bacteriological condition of the water supplies of the dairy farms is considered here, and although it is impossible to determine accurately the condition of the milk which is sent out from a dairy farm by the relative pollution of the water supply of that same farm, it may fairly be classed as an inferential method of diagnosing the probable danger of similar pollution occurring in the milk. It is possible, of course, that by using only hot water for rinsing cans and bottles and using proper sanitary methods, milk of an exceedingly high purity could be distributed from a farm whose water supply was badly contaminated, but as Professor Sedgwick says in his Principles of Sanitary Science, "The fact appears to be that the dairy industry is as a rule still in a very primitive state."

In the course of this brief survey about fifty dairy farms have been visited in representative regions of Maryland, Virginia, and the District of Columbia, and the number of bacteria in the water supplies determined, and also the presence or absence of the colon bacillus. To make the tests as strictly representative as possible, the work of plating water samples and inoculating fermentation tubes was carried on entirely in the field, the water being sampled and plated immediately upon being taken from the well or spring. The accompanying diagram shows the condition bacteriologically of the various samples taken, and as every precaution was used to secure representative samples, it seems fair to assume that this is a fairly accurate chart of the conditions obtaining in the wells and springs.

Although there is a great diversity of opinion as to what bacteriological limits are proper for well water, we may perhaps fairly assume that the wells containing less than 500 bacteria per cu. cm. and not showing the presence of B. coli to be good water supplies. Where local conditions appear to give a reason for a high bacterial count of harmless bacteria, water supplies containing less than 5,000 bacteria per cu. cm. and not showing the presence of B. coli may be counted as safe water. The presence of over 5,000 and less than 10,000 bacteria per cu. cm. when the colon bacillus is not present may be considered suspicious, and water containing more than this number of bacteria should be considered unfit for use. The presence of the colon bacillus must be studied in connection with total count and in connection with the local conditions in order to determine the relative importance of its presence; or, in other words, its relative importance as indicating sewage pollution. Under these divisions we would be forced to class the various well waters indicated in the charts as 16 good, 15 fair, 17 suspicious, and 12 unfit for use.

Using this survey of a few dairies in various regions in the neighborhood of Washington as the criterion for judging the condition of all of the dairy farms, it would seem highly probable that, under the conditions portrayed, much of the typhoid of the city of Washington may be ascribed either directly or indirectly to the unsanitary dairy farms.

*A paper read at the New York meeting of the Society of American Bacteriologists, Dec. 29, 1906.

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ANNUAL MEETING OF THE ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.

The twenty-second annual meeting was held at Peoria, Ill., on Jan. 23, 24 and 25. In point of attendance and technical interest, the meeting was notably successful. At the afternoon session on Jan. 23 an address of welcome was delivered by the Mayor of Peoria, Mr. A. B. Tolson. Mr. Dabney H. Maury, M. Am. Soc. C. E., Chief Engineer of the Peoria Water Co. and President of the Society, then delivered the annual address.

PROGRESS IN PUMPING MACHINERY.

Taking this as the subject of his address, Mr. Maury reviewed the development of different types of pumping engines, and also of deep-well pumps, the latter including reciprocating pumps, the air-lift and the use of centrifugal impellers carried by a vertical shaft within the well. The three latest and most important developments are the steam turbine, the improved centrifugal or turbine pump, and the gas engine with producer. He considered that the proper adaptation of the steam turbine to the turbine pump is only a question of time. A comparison of the first cost and the duty of different types of pumping machinery of 10,000,000 gallons capacity daily against 100 lbs. pressure (which would correspond to 400 water horse-power) shows the following result: (1) A vertical triple-expansion condensing engine-plant (with boilers, etc.) could be erected for $70,000, and would consume 1.4 lbs. of coal per water horse-power per hour; (2) a steam turbine, with turbine pump, would cost $30,000 and consume 1.8 lbs. of coal per water horse-power; (3) a gas producer plant, with engine and direct-connected turbine pump, would cost $50,000 and consume 1.35 lbs. of coal per water horse-power per hour. The reciprocating engine will in most cases (except when the cost of coal is very high) prove a more expensive investment than the turbine plant, while in the near future the gas-producer pumping plant is likely to prove a better investment than either of the others.

MUNICIPAL ENGINEERING OF PEORIA.

Three papers were then presented by local engineers to inform the members generally as to engineering matters in the convention city. Mr. C. M. Dolan first presented a paper on "Street Pavements and Sewers," showing that Peoria, with 8.42 sq. miles of area, has 55.45 [illegible] of paved streets: 40.59 miles of brick, 12.70 [illegible] of asphalt, and the balance of stone block, cobble-stone and novaculite. "Asphalt pave[illegible] in good condition are smooth and noiseless; [illegible] are more expensive and wear out sooner than brick, but people will drive blocks out of their [illegible] in order to travel over them." The city has 84.26 miles of sewers, of which 21.59 miles [illegible] of brick and the balance pipe. The combined system is in general use, although portions of the city have sanitary sewers only. In the district on the bluff there are catch-basins of several hundred gallons capacity, which hold the storm water for a time, thus giving the main sewer a chance to get rid of what storm-water [illegible] below the hill before that from the bluff reaches it.

This was followed by one on "The Water Supply System," by Mr. T. L. Burkland, Assistant Engineer of the Peoria Water Co. The gas, electric and steam heating plants of the Peoria Gas & Electric Co. were then described by Mr. Llewellyn Owen, Assistant Engineer. There are 125 miles of mains, with 160 miles of services for 9,500 consumers. The electric-light plant has 4,800 consumers, using 807 street arc lamps, 1,123 commercial arc lamps, 113,000 incandescent lamps of 16 c. p., and motors of 3,050 HP. The steam heating system has 6,949 ft. of 4-in. to 18-in. pipe, supplying 117 consumers with 146,000 sq. ft. of radiation. It also heats three hot-water systems.

The report of the Committee on Mechanical and Electrical Engineering was then presented and briefly reviewed a number of developments in power and lighting work, particularly in regard to the steam turbine and the gas engine with producer plant.

A paper on the single-phase interurban lines of the Illinois Traction System was then read by Mr. H. C. Hoagland, Electrical and Mechanical Engineer of these lines. A paper on "The Paving of Streets on Heavy Grades" was then read by Mr. C. G. Anderson, City Engineer of Moline, describing different styles of paving employed under these conditions, with the results obtained.

At the evening session Mr. D. H. Roberts, Assistant City Engineer, read a paper on the new city bridge now under construction across the Illinois River. This bridge will have five concrete arch spans with the Melan system of reinforcement, with lattice arch ribs and Thacher bars. There will also be a Scherzer 142-ft. rolling-lift bascule span. The leaves of this span have deck girders with curved bottom chords, so that when closed it will harmonize in appearance with the arch spans. The arch spans were designed by the Concrete Steel Engineering Co., of New York, and the contract was let to the Marsh Bridge Co., of Des Moines, Iowa. Just above this bridge the Illinois Traction Co. is building a steel bridge for its new Peoria and Bloomington interurban (single-phase) line. This has four through truss spans of 142 ft. 10 ins. c. to c. of piers, a 140-ft. Scherzer rolling-lift deck span (with curved bottom chords to the girders), and plate-girder approaches. This was designed by Mr. Ralph Modjeski, M. Am. Soc. C. E., of Chicago.

THE GEOLOGICAL AND WATER SURVEYS OF ILLINOIS.

A paper on "The Work of the Illinois Geological Survey" was read by Mr. H. Foster Bain (Urbana), Director of the Survey. The work comprises two lines of work, topographic and geologic, and the first of these is carried on in co-operation with the U. S. Geological Survey. During the field seasons of 1905 and 1906 there were 2,492 sq. miles mapped, at a cost of about $16 per sq. mile, including primary triangulation and precise levels. The geologic work has so far been concentrated mainly upon a study of the coals and clays of the State. A paper on "The Test of Illinois Coals," dealing with tests made at the Engineering Experiment Station in connection with the work of the Survey, was read later by Mr. H. B. Dirks, of the University of Illinois. In 1904 important deposits of petroleum were discovered in the southeastern part of the State, and the output per month had increased to 800,000 barrels in August, 1906.

The work of the Illinois Water Survey during the past year was dealt with in a paper by Mr. E. Bartow, Director of the Survey (Urbana). The work may be classified as follows: (1) There were 1,126 analyses made of water sent in by citizens to determine its potability or its availability for boilers and industrial purposes; (2) in cooperation with the State Board of Health, examinations were made of five sewage disposal works, all of which were shown to be lacking in efficiency, usually due to neglect on the part of those in control; (3) a beginning has been made in a study of the municipal water supplies of the State; (4) in a special examination of the streams of Illinois the Survey has cooperated with the Division of Hydro-Economics of the U. S. Geological Survey.

As a result of the two papers and the discussion following them, a special Engineering Investigations Committee was appointed to cooperate with the Illinois Geological Survey, the Illinois Water Survey, the Illinois State Highway Commission, and the Engineering Experiment Station of the University of Illinois. At a later session this committee presented resolutions urging upon the State Legislature that the present policy be continued and that liberal appropriations be made for carrying out the plans of these departments. These were adopted.

WATER SUPPLY AND SEWERAGE OF GARY, IND.

The water supply and sewerage systems of the new industrial town of Gary, Ind., now being created by the United States Steel Corporation, were described in an interesting paper by Mr. John W. Alvord, M. Am. Soc. C. E. (Chicago), presented at the morning session on Jan. 24:

We plan to provide water by means of a tunnel extending beneath the bed of Lake Michigan, taking water from a submerged intake 7,000 ft. from the shore and conveying it three miles to the center of the city. It is estimated that this tunnel will yield more than 60,000,000 gallons per day. From the shore shaft of this tunnel the water will be pumped with transmitted electric power generated by waste gases from the steel plant. The pumping units will probably be motor-driven centrifugal pumps, and the pumping station will be located in a public park in the center of the city.

With 10,000 to 12,000 workers in the steel mills, 50,000 to 60,000 residents are expected, and two square miles of completed city area are being laid out and provided with sewers; water, gas, electric light, paving and sidewalks. The price of these improvements is added to the cost of the lots, which are sold subject to reasonable building restrictions. The city is incorporated under the laws of Indiana. The steel works will cover about two square miles adjoining the lakes, and will have a pumping plant of 100,000,000 gallons daily capacity. The writer is only charged with the design and construction of the water supply, sewerage, drainage and sewage purification of the city proper. About 21 miles of 6-in. to 30-in. water distribution pipe is now being laid. All pipes and sewers are laid in the alleys, so that the street improvements will not be impeded or injured. This location presents certain difficulties which are overcome in this instance by reserving right-of-way through and along the edges of certain lots for connections to hydrants and catch-basins, which are desirably placed in the center of the long blocks. This method probably would not be practicable with varied ownership.

As the Calumet River has a minimum flow of hardly two or three cubic feet per second and as the only other outlet for drainage, Lake Michigan, is required for water supply, it is evident that sewage purification must be extensively introduced. The general elevation of the city is 18 to 20 ft. above Lake Michigan, and a combined system of sewerage was adopted for the following reasons: (1) A separate system, especially if placed lower than the storm-water sewers, would be filled with a large amount of percolating soil water, in spite of every attempt to make the sewer wells tight; (2) the porous nature of the sandy soil and the flat character of the country do not indicate a large run-off per unit of area; (3) a reasonable amount of dilution water in sewage rather facilitates its artificial purification, but does not require proportionate increase in capacity of the purification plant. These considerations decided the question in favor of a modified combined system with capacity equal to those drainage systems used in the outlying sandy districts of Chicago.

The sewer system is to empty its flood water into the Grand Calumet River, and have its dry weather flow pumped to a purification plant. This decision is confirmed by two features peculiar to this locality: (1) Sandy soil for intermittent filtration is plentiful, and the adoption of sedimentation or septic action, followed by intermittent filtration, is indicated as the most economical and advantageous adaptation of the local resources of the district to the purposes of sewage disposal. (2) The operation of the steel plant will cause the waste of about 75 cu. ft. per second of fresh water from condensers and other machinery to a point near the mouth of the sewers, and it is believed that this will keep the river in good condition in spite of the occasional storm-water overflow from the sewers. The site for the filtration plant and its details have not yet been worked out, but it will evidently be of considerable capacity.

In connection with the sewerage and drainage of Gary, interesting studies have been made as to ground water percolation in sandy subsoils, both at Indiana Harbor and in the suburban sandy districts of Chicago. From these studies it is believed that the percolation into the sewers at Gary will not exceed 1,000,000 gallons per day per square mile, after the ground water has finally taken its new lower level.

ROADS AND STREETS.

A review of the work of the Illinois State Highway Commission was given by Mr. A. N. Johnson (Springfield), State Highway Engineer. He exhibited diagrams of the traffic census made on individual roads, showing the variation from day to day, as affected by weather and other conditions. He also described the character of reinforced-concrete highway bridges designed by him for use on country roads. During the past three months plans have been prepared for 16 bridges, and applications for others are on file. The first four bridges constructed under the plans of the Commission were said to have saved $10,000 to the local communities. A paper on "Granite-Top Macadam Streets in Oak Park, Ill.," by Mr. R. A. Carpenter (Commissioner of Public Works) was read; we shall give an abstract of this, but it may be noted that the paving is 15½ ins. thick. In the report of the Committee on Roads and Pavements particulars were given of the character and cost of street work done in several Illinois cities during 1906. It also gave the following particulars of the new guarantee system in Chicago:

Specifications for pavements in Chicago have recently been revised and some radical changes have been made. The 10-year guarantee formerly required on all except macadam has been reduced to five years, and in place of a surety bond the city retains 5% of the amount of the contract. If the work is found in good condition, one-fifth of this percentage is paid to the contractor on Dec. 1 of the year next following that in which the work is completed, and a like amount each succeeding year under the same conditions. It will be noted that a contract completed after Dec. 1 is practically guaranteed for six years. The wisdom of reducing the guarantee period from ten to five years, especially on asphalt pavements, is questionable. Bids received since the change show that it has reduced the price for asphalt from 5% to 10%, but while this will reduce the burden placed upon the property owner it will greatly increase the rapidly growing repair bill which the city is called upon to meet. Experience shows that asphalt pavements are not adapted to streets subjected to very heavy traffic, especially if they have street-railway tracks, and streets paved with asphalt in the "downtown" section of Chicago need repairing about every month.

The change from the bonding plan to the cash reserve plan was induced by the fact that a number of contractors have refused to make repairs, or have gone or been forced out of the paving business, and have left it to the surety companies to maintain their work in good repair. These sureties usually find it cheaper to let the case go to the courts than to make repairs; the matter then drags along for years, and in the meantime the city is forced to make the repairs to keep the streets in passable condition. A clause in the contract under the cash reserve plan gives the city the right to use the money retained not only upon the particular contract which it may find necessary to repair, but to use any money that may have been similarly retained from the same contractor upon any other contract.

A paper on "Paving Brick and Brick Paving" was then read by Mr. W. P. Blair, Secretary of the National Association of Paving Brick Manufacturers, who exhibited specimens of good, bad and indifferent brick. This was followed by a general discussion on the subject of paving, in the course of which Mr. Maury stated that in a court case witnesses said that the concrete foundation of a street kept the ground dry beneath it. This led to investigations, and in practically every case the reverse was found to be true. In one case, where the ground beneath the concrete was so moist that it could be worked up into a ball with the hand, beyond the concrete foundation the same material (in the same street) was quite dry. It was also remarked that a concrete street foundation has been claimed to be sufficient insulation to prevent current from street railway tracks escaping into the ground, but there is no proof that this is the case.

WATERWAYS AND CANALS.

The evening session on Jan. 24 was held in the assembly room of the City Hall, and papers were read on the proposed deep waterway to the Gulf. Mr. R. R. Bourland dealt with the project in a general way, and the papers by Mr. J. W. Woermann and Mr. J. A. Harman dealt with the engineering features of the work along the Illinois River between the Chicago Drainage Canal and the Mississippi River. This portion would be about 365 miles long, with 200 ft. difference in elevation, obtained by means of nine locks, 80 × 640 ft. There would be about 20 bridges, and a movable dam of the Chanoine type. The cost of this work is estimated at $30,000,000.

THE HENNEPIN CANAL.—This shallow-draft boat canal was the subject of a paper presented Jan. 25 by Mr. F. W. Honens (Sterling). This canal is 75 miles long, with a 29-mile feeder; it rises 199 ft. in 18 miles from the Illinois River to the summit level (with 21 locks), and then falls 96 ft. in 46 miles to the Mississippi River (with 11 locks); the feeder has a single guard lock. The canal is 52 ft. wide on the bottom and 80 ft. at the water level, with 7 ft. depth of water. The locks are 35 × 170 ft., and turnouts, or passing places, are provided at intervals of four or five miles. There are nine aqueducts, having four to ten concrete arches of 35 ft. span; the trough for the canal is of structural steel, with a reinforced-concrete lining, and is 39 ft. 6 ins. wide between the guard or waling timbers. There are nine railway bridges, 67 highway bridges, and several pontoon bridges for farm crossings. The new dam in the Rock River at Sterling will raise the water level 9 ft.; this has a fixed portion 588 ft. long formed of rock-filled crib-work. The end portions are of concrete and contain sluices 21 ft. wide, fitted with cylindrical steel gates. There is also a 35-ft. needle dam in one end. The work on the main canal is now practically completed, and it is expected to be open for navigation early in 1908.

DRAINAGE.

Land drainage is an important subject in Illinois and the Central States, and two papers were presented on this subject. The Sny Island Levee drainage district was described by Mr. W. P. Bushnell (Quincy, Ill.), Chief Engineer of the district, which was organized in 1871 and is the first one formed in Illinois. Levees were built to exclude flood waters, and drainage ditches are formed by dipper and suction dredges. A paper by Mr. L. G. Hicks (Omaha, Neb.) described the tile drainage of a 75-acre section of a valuable estate; no crops (not even grass) could be grown on account of the sour and wet condition of the soil, but the first crop of corn after the completion of the drainage more than paid for the cost of the work.

MISCELLANEOUS.

The report of the Committee on Surveying consisted principally of the instructions which were issued to field parties on the government survey of the Illinois River in connection with the proposed deep waterway. There were also some notes as to the use of Invar nickel-steel tapes by the U. S. Coast and Geodetic Survey. A paper by Mr. A. L. Webster (Wheaton, Ill.) dealt with "The Surveying of Subdivisions," and also with the increase in length of surveying chains by wear of the links. The report of the Committee on Architecture reviewed the points to be observed in the construction of reinforced-concrete buildings to ensure good and safe work. A list of the exhibitors at the meeting is given in our Construction News Supplement.

ENTERTAINMENTS.

The afternoon of Jan. 24 was devoted to an excursion, a special electric car being furnished by the Illinois Traction System. After a visit to one of the large distilleries, the party proceeded to the new power-house of the interurban line, and to the two new river bridges. The remainder of the time was spent in inspecting the pumping plant of the Peoria Water Co., under the guidance of Mr. D. H. Maury. In the evening and after the session at the City Hall the party adjourned to a "smoker" at the Creve Coeur Club, given by the local members.

BUSINESS MEETING.

The report of the Secretary showed the following financial results: Receipts, $1,540; expenditures, $986; balance, Dec. 31, 1906, $554. The Society has now 190 members. The election of officers resulted as follows: President, C. B.

Burdick, Chicago; Vice-President, A. N. Johnson, Springfield, Ill.; Trustees, J. A. Moore, Chicago, and R. S. Wallace, Peoria. The Secretary is E. E. R. Tratman, of Chicago. The next meeting will be held at the University of Illinois, at Champaign, in January, 1908.

SINKING A FLOWING WELL FOR THE WATER-WORKS OF SALEM, VA.

By J. N. AMBLER.*

Due to the steady growth of this town and the greater proportionate growth in the water consumption, it was found necessary to develop a supplemental supply which might be called upon in time of drought. At all other times the present source (Lake Spring) has proved amply sufficient.

A searching examination of the entire Roanoke valley for miles disclosed no source of supply which might be relied upon in times of low water, except one whose distance rendered its development impracticable, with the means at hand. The town council, yielding to the wishes of the people, decided to risk the necessary outlay to sink a deep well, before going so far away for their supplemental supply. A site for the well was chosen, as shown on the accompanying map, the desire being to place it near the pumping station, where steam from the present boilers might be supplied to run a deep-well steam pump, should this type be selected. An objection to this location is the sewer running between the lake and the site selected.

Several specifications were prepared by the writer. These informed prospective bidders of the geological character of the formations which would be encountered. A minimum depth of 500 ft. and a maximum of 1,000 ft. were determined upon for an 8-in. hole. The town reserved the right to have 200 ft. of 12-in. hole sunk, if desired. The amount and character of the casing were left optional with the engineer. A drive shoe was to be used at the foot of any line of casing, and the interval between the casing and the wall was to be grouted with cement mortar. Other provisos related to the measurement of the hole by the engineer.

It was not thought advisable to require bidders to guarantee anything, except it was provided that no hole rendered useless by breaking off or hanging of the tools would be accepted by the town. The contractor was required to furnish necessary apparatus, and make such tests from time to time as the engineer might require, for which a per diem compensation would be allowed. Of course, under such specifications bids on the 8-in. and 12-in. holes were invited to be by the foot of completed well. Casing, cementing, drive shoes and testing were to be extra.

The contract was awarded to the A. W. Drake Drilling Co., of Hazelton, Pa., at the following prices:

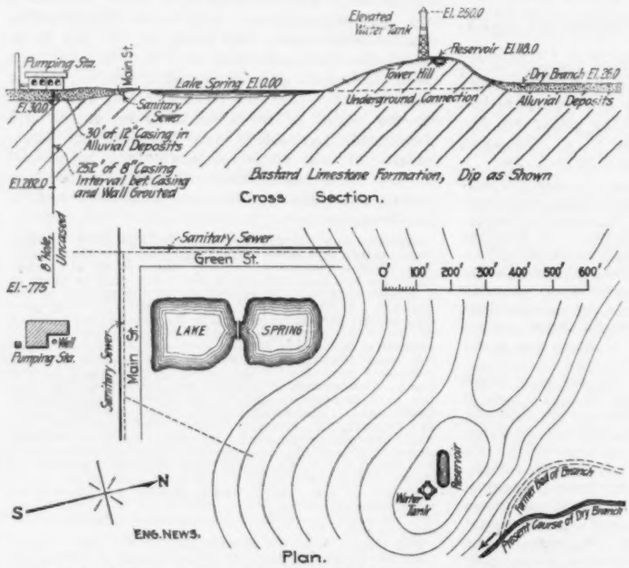
Drilling of 12-in. hole	$4.00 per lin. ft.
Drilling of 8-in. hole	3.00 " "
12-in. casing in place	1.95 " "
8-in. casing in place	.95 " "
12-in. drive shoe in place	25.00
8-in. drive shoe in place	7.50
Testing well	15.00 per day of 24 hrs.

Drilling was begun early in December, 1905, and the work was not completed until Nov. 10, 1906. At that time the depth of hole was 775 ft. The first 30 ft. of 12-in. hole was through an alluvial deposit of sand, clay and rounded boulders. Many seams of water were encountered in this deposit, the water inside the well standing at about the level in the lake most of the time.

As a 12-in. bit will open a hole 14 to 15 ins. in diameter in this kind of material, it was very easy to place a 12-in. steel casing, to prevent caving. This pipe was connected by ordinary collar joints and provided with a drive shoe, by means of which a very tight connection was made with the rotten upper strata of the limestone. There was no further trouble from caving, and no visible effect upon the water level. Through this 12-in. casing a 12-in. hole was drilled to a depth of 252 ft. below the surface. This was afterward cased off with an 8-in. steel casing, with collar joints and a drive shoe. As the bottom of the hole had been tapered for some 5 ft., this shoe was driven to a very firm bearing. The 8-in. casing extended entirely to the surface, and it was intended to pull out the 12-in. pipe and grout all the space between the 8-in. pipe and walls of the hole for the entire 252 ft. It was found, however, that the earth had caved in around the 12-in. pipe to such an extent that it was not thought wise to clear it, but to grout between the 8-in. pipe and the 12-in., and as well as possible between the 12-in. pipe and the wall.

It was not intended originally to place the 8-in. casing until it was ascertained to what depth it should be carried. However, the continual caving in of small cubical blocks of limestone from the wall jammed the tools so frequently, and interfered with the drilling to such an extent, that it was found necessary to case off the first 252 ft. The only indication that this depth would be sufficient to protect the well from downward percolation of shallow waters was that at this depth a fairly solid and hard stratum of calcareous sandstone had been attained.

The entire depth of the well was carried through the lower Silurian formations, which here consist of varying degrees of limestone, from one rich in lime to a calcareous shale on the one hand and sandstone on the other. All will effervesce in dilute acid. These formations are more or less metamorphosed, and so crushed and contorted by mountain-making processes that they seem to be capable of passing any amount of water through the countless cracks and fissures. Some strata were 20 to 30 ft. thick, while in other cases the rock would vary every 2 to 3 ft.



PLAN OF SITE OF FLOWING WELL AND SECTIONAL PROFILE THROUGH WELL AND VICINITY, SALEM, VA.

The indurated and crushed condition of the rock accounted for the difficulties found in drilling and the very slow progress made. The cracks and fissures also accounted for the peculiar behavior of the water and the difficulty in controlling it in any degree. A good average rate of drilling, when all was going well, was 3 to 5 ft. per day. As much as 7 ft. per day has been made, while for many days at a time an average of less than 1 ft. per day was all that could be made.

The behavior of the water in the well during all this time was extremely peculiar. It often rose to the level of the lake, though it usually stood from 5 to 9 ft. lower. It sometimes stood at 13 ft. below for days at a time, and on one occasion went down to something like 50 ft.; within the next few days it was back at its old level. One day the water was standing almost at a level with the top of the casing and was observed to be slowly crawling up in the pipe. Within a few minutes, and while still under observation, it began to recede. These fluctuations have never been accounted for, though the writer endeavored to connect them with the pumping carried on from a 300-ft. well at a tannery about 1,500 ft. distant, and another at an ice plant about a mile off.

No additional supply of any consequence was gained until at a depth of 548 ft., when a slight rise of the water level in the hole and the cleaner condition of the sand pumpings indicated a small stream. Below this depth the drilling became increasingly difficult, several thick strata of crushed stone being encountered. At times it was well-nigh impossible to proceed through the formation without putting down a 6-in. casing, which reduction of size of hole was considered undesirable. At 761 ft. a considerable stream of water was encountered, the water inside the casing now rising to about the surface and overflowing several times. The water-worn character of the fragments raised by the sand pump also indicated a considerable stream.

In hope of further increasing the supply, the drilling was continued down to 775 ft., when an uprush of thick blue mud filled the hole for 30 ft., this being 16 ft. above the entrance to the main stream. This mud became so mixed with fragments of stone from the crumbling walls that it could not be moved to any advantage with the sand pump. An effort to beat up the mass with the drill tools resulted in failure, as the mud seemed to cushion the blows of the drill. As an experiment, a 2-in. pipe was coupled and let down to the surface of the mud. This pipe was provided with a nozzle at the lower end and was connected, by means of a flexible, wire-bound rubber pipe, to a connection on the force main leading to an elevated water tank, thus making available some 250 ft. head of water. The jet thus produced loosened the mud and washed it all out of the rock and out through the surface end of the casing. The rock fragments were afterward pounded up and removed with a sand pump.

A point had now been reached where efforts to proceed further were met with ever increasing difficulties, from caving walls and mud. The contractor claimed that it was impossible to proceed further without using a 6-in. casing. As some weeks had been spent drilling without making notable headway, and accidents which caused long delays were happening in rapid succession, it was finally decided to stop at this depth.

It now became necessary to grout the hole. In order to release any debris which might have accumulated around the drive shoe of the 8-in. pipe it was determined to raise the 8-in. casing a few feet, to allow such debris to fall into the lower part of the hole. So tight a connection had the pipe made in the tapered hole, and so tight was the roll of burlap wrapped around the lower end to hold the grout, that four jacks could not raise it. It was then attempted to grout the casing as it stood. Old Dominion Portland cement was used, without sand, as the latter would separate from the cement in passing through so much water. A mixing box, with water connection and outlet, was placed near the hole, and 12 bbls. of cement were run into it without making any visible impression. On lowering the sand pump it was found that nearly all of this cement had found its way by the foot of the

*Engineer-in-Charge of the well; City Engineer of Salem, Va.

8-in. casing, in some way, and was at the bottom of the well. It developed later that when the sand pump was held about 15 ft. below the 8-in. shoe it caught whatever cement was poured in, while if held higher it failed to catch any. This was taken as showing that the 8-in. shoe and burlap were holding the cement properly, but it was passing around this shoe through a fissure connecting the well above the shoe with the part below. This view was confirmed by recalling the fact that when water was forced down into the hole through the 2-in. pipe it came out all around the casing at the surface of the ground, and even through an old, abandoned well some 20 ft. away.

It was concluded that if the communication with the surface was thus free, in a closely settled region, with sewers, privies and cesspools, unless communication could be entirely cut off, the well would be worth less than nothing. The following experiment for cementing the interval between the 8-in. pipe and the wall was tried:

The hole was filled with sand from the bottom to a point some 20 ft. above the 8-in. shoe. The cementing was then resumed, it being hoped that the sand column would rise into and fill the fissure enough to act as a support for the cement until it set.

The continued pouring of cement into the interval still made no impression, so as a last resort some six wagon loads of sand were run in. This seemed to fill up the fissure. After this, the cementing was continued up to the surface. With this the water level rose until it overflowed the casing. It is now running through an elbow screwed into the reducer with which the top of the casing is closed. The flow is on a level of about 2 ft. above the lake. The very slight pressure shows that it would not rise much higher. The natural flow above the surface has varied from 21 to 45 gals. per min. When the well was pumped continuously for 42 hours, 140 gals. per min. were taken out, without lowering the level more than about 9 ft. This test was made with a piston pump barrel attached to the walking beam of the drill machine. As this was the maximum rate of pumping possible by this method, it is not known how much more water could be obtained when pumped with some form of air lift. Due to exhaustion of appropriation, no pumping apparatus has been installed as yet.

While the present overflow is, of course, due to a more or less distant source, it is not known how much of the 140 gals. per min., with a lowered level, is due to inflow from the lake through deep crevices, nor how much of the distant source is finding its way into the lake while a small amount is overflowing. As several known connecting fissures exist between the lake and the gravel beds of "Dry Branch," north of tower hill, the inference is easy that the source of the well's supply is no more remote. The water of Dry Branch is soft, and the water of the well being soft also, though coming through nearly 800 ft. of limestone formations, lends strong color to this view.

The opportunity to observe the effect of drought and sub-surface pollution on this remarkable well is awaited with interest.

THE LINE OF ADVANCE IN WOOD PRESERVATION.*

By CARL G. CRAWFORD.†

In the question of the recent development of wood preservation we are unavoidably carried back to the beginning of the twentieth century. To the changes which were then inaugurated, or which were at that time first brought to the attention of the public, is due the marked development in wood preservation which reached so gratifying a height in 1906.

Prior to the year 1901, about fifteen timber treating plants were operated in the United States; most of these were using methods which had been brought over from Europe several years ago; even if American improvements had been made originally, all progress and development seemed comparatively at a standstill. The great bulk of the work was confined to a few classes of material, for which the practicability of artificial preservation had long been established and little effort was made to better the treatment, or to extend the industry to new purposes. The operators to a large extent were working in ignorance of each other's methods and there was little opportunity for discussion and mutual improvement; nor was there any concerted action for extending the activities of the industry. The public was largely ignorant of the processes in use and even of the principle itself of artificial preservation; in certain quarters, moreover, there prevailed the mistaken idea that a more thorough public knowledge should be discouraged. Also, the complex chemical character of creosote, and the difficulty of detecting adulterations, induced fraudulent transactions, with the inevitable result of bringing public distrust upon the entire industry.

Even the largest consumers of treated wood lacked a well-balanced knowledge of the particular advantages and limitations of each of the several methods of treatment. In certain cases too much was expected, hence dissatisfaction arose when the preservative protected the timber merely from decay and not from mechanical wear. In others, they failed to avail themselves of the full advantages which the treatments offered; thus, we read of the unwise use of soluble antiseptics in situations subjected to excessive moisture. For overcoming these unfavorable conditions and establishing on a firm commercial basis an industry which will continually increase in importance and national benefit, much credit must be given to those far-sighted engineers and operators of wood-preserving plants who by their incessant efforts and the uniformly high character of their work dispelled public ignorance and distrust and opened up the way for the rapid advancement of the past few years.

However, it is improbable that any personal efforts could have availed against the fierceness of commercial competition which then prevailed among the large consumers of structural timber, compelling the sacrifice of future good to present necessity, had they not been assisted by two monumental changes in the economic conditions of the country. Of these, the one of greater importance has been the near approach of a serious shortage in the supply of structural timber. It is only a few years since the forest resources of the country were almost universally believed to be inexhaustible, that unlimited forests lay beyond the ones which were then being exploited, and that as railroads and sawmills penetrated deeper and deeper into the wilderness the supplies of timber would be augmented rather than decreased. How seriously mistaken this idea, and how a newly aroused and more truthful sentiment is now making itself felt, it is unnecessary for me to recall. Consumers now realize that artificial preservation must be employed not alone in those cases where the renewing of the timbers is unusually expensive; and that its principal benefit lies in the future reduction it will afford in the required amount of structural timber.

Of almost equal importance has been the indefinite but none the less radical change which has taken place in the economic and industrial situation of the United States. The feeling of insecurity, of uncertainty of the developments of the future, which so strongly characterized the last decade of the nineteenth century has now yielded place to more normal conditions, and for almost the first time in the industrial history of the country capitalists feel at liberty to build upon future conditions and developments. This has, as a logical consequence, permitted the investment of large sums in preserving the timber used in extensive engineering enterprises. And the extent to which present dividends can safely be reduced in order to yield a greater return in the future can be proved with almost as great accuracy as any other detail of a large financial enterprise. It may even be said that these conditions are almost sure to be intensified and that the coming years will prove that a prudent regard for the future supply of timber is even more imperative than it now appears to be.

As a result of these two causes, together of course with others of minor importance, the last few years witnessed a great activity in wood preservation throughout the entire country. This activity may be said to have manifested itself along the following lines:

1. Increase in the number and capacity of treating plants.

2. Improvement in the existing methods, introduction of new methods from abroad and development of methods particularly American and designed to meet American requirements.

3. Promoting a more careful and detailed study of the technology of the American woods and an investigation of the constituents and properties of the preservatives in general use.

INCREASE OF PLANTS.—Of the first of these it is unnecessary for me to speak. In the thirty years preceding the twentieth century, not more than fifteen plants had been erected. In the following six years this number was increased to nearly fifty, while in 1906 alone not less than five plants were erected. And you are all familiar with how their capacity has increased from one or two retorts to the present equipment of five or six; how their length has increased to 160 and 180 ft. and the diameters to 9 and 9½ ft.

It is, therefore, the second and third of the points I have enumerated on which I wish to more particularly speak. The ultimate aim of every method of wood preservation is, of course, to adapt the treatment to the species and the conditions in which the treated wood will be permanently placed and in proportion to its success in fulfilling these two objects economically and efficiently, the value of the process must be judged.

DEVELOPMENT OF PROCESSES.—The economical conditions in Europe during the middle of the past century were such as to stimulate the development of the wood preserving industry at a time when neither the industrial situation of America nor the probability of a future scarcity of structural timber could justify a similar movement in this country. Hence, when the conditions in America became analogous to those in Germany, France and England, it was natural that we should look to these countries for our experience in our first efforts to effect a remedy. Thus, our first methods in America were wholly of foreign origin. Some of them had proved to be of decided value in the old countries, while others had scarcely passed the experimental stage before their importation.

On being transplanted to American soil, and compelled to meet American conditions, some of these processes adapted themselves readily to their new environment and now may be regarded as permanent factors of importance in the future development of the industry. On the other hand, the explanation of the failure of other processes after introduction to this country, must be attributed to one or both of two causes: either to some inherent and fatal defect in the methods themselves which had remained unknown or had been hidden from their American exploiters, or to their inability to meet American conditions and competition. But the point I want to emphasize is that, whether these foreign processes have failed or succeeded, their greatest value in this country has been in the modifications and innovations which they have suggested and in the interest which they have stimulated.

This study of the various processes in their modified forms has brought into prominence the true value of the essential features of each process; and it is, therefore, easier to determine where they should be applied and in what cases they may be safely omitted. This, together with our more intimate knowledge of American woods, has enabled us to simplify and cheapen many of the other processes, when applied to certain species. Thus, while it is recognized that, under certain conditions, the application of pressure must play the most important part in the treatment of certain species, it has also been demonstrated that it may often be entirely omitted and that greater emphasis should be placed upon the preparation of the wood before it is subjected to artificial preservation. The recognition of this fact a comparatively short time ago now promises to result in the development of a simpler and cheaper method than any in previous use.

During the past year, the Forest Service conducted several series of experiments on what has now come to be known as the open-tank method. Timber in various forms was treated: fence posts, telephone poles, crossarms, mine props, railroad ties and other forms. While, as might naturally be expected, this method cannot be applied promiscuously to all species of American timbers, yet it has been studied with sufficient thoroughness to make clear that it is of permanent importance and that its influence will greatly increase as its practicability is extended to new species and to new purposes. It also permits the benefits of preservative treatment to be extended to industries where some method of wood preservation is desired, but for which the more elaborate processes are too expensive. However, its value to the industry as a whole does not stop here, but the study which has been devoted to it has also thrown a new light upon other points.

When the method was first introduced, the penetration was supposed to be due largely to the evaporation of the moisture in the wood, with a consequent creation of a vacuum. Hence, it was supposed that green timber could be treated better than seasoned. Our experiments, however, have shown that successful penetration is not due so much to the expulsion of the water as to the expansion and escape of the air in the structure of the wood. These experiments have also furnished additional evidence of the poor qualities of wood as a conductor of heat, and therefore, of the difficulty of obtaining temperatures in the interior of large timbers sufficiently high to volatilize the moisture in the wood cells. It is less difficult, however, to expel the air and to enlarge the openings in the cell walls with heat so as to increase the ease of circulation between the different cells. Thus the penetration secured by the open-tank treatment can be regulated more exactly by varying the length of its immersion in the cold preservative rather than in the hot; for, if the timber is allowed to remain for several hours in the hot preservative, and is removed from the cold liquid before the vacuum is wholly destroyed, the oil or solution in the outer, saturated zone is drawn in, and the surface is left comparatively clean and dry. If the conditions of

*A paper read at the annual meeting of the Wood Preservers' Association at Memphis, Tenn., January 16, 1907.

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the treatment are reversed, however, a vacuum is established only in a thin exterior layer. This area is soon penetrated, and as there is no inward suction, the cells remain in a saturated condition and the oil drips out over the surface.

PREPARATORY PROCESSES.—A study of the preparatory processes commonly used in the artificial seasoning of timber for preservation has also thrown new light upon the real value of steaming and vacuum. The superiority of air seasoning over any mechanical process or device has been clearly shown, but at the same time it is recognized that timbers which are of dense structure, or which do not receive a uniform penetration, should be subjected to some artificial preparatory process. The complaints which have hitherto been made have been occasioned by the abuse of such processes rather than by the processes themselves, and our increased knowledge has permitted us to employ them without injuring the timber. We know that the real value of steaming timber lies in its ability to warm the wood, rather than in its seasoning effect or in decomposing and dissolving the organic materials in the cell walls and cavities. We also know that the long steaming is often unnecessary and even injurious, and by increasing the cost of preservative treatment and detracting from the structural strength of the material proves a serious detriment to the extension of wood preservation. For many species, also, more exact information has been obtained about the amount of moisture in the green state: how much must be seasoned out before treatment, and what forms of piling and what length of time are necessary to bring this about.

A result of far-reaching importance has been the comparatively recent effort to adapt the form of treatment to the technological structure of the material. If the statement had been made several years ago that not only the preservative, but the treating plant itself must be adapted to the peculiar structure characteristics of the timber with which it was expected to deal, the speaker would have been considered an impractical theorist. But so great has been the extension of our knowledge within the past few years that now the character of timber is fully considered before deciding upon the process of treatment or erecting the plant.

CHOICE OF PRESERVATIVE.—It is also gratifying to note that the choice of the preservative is now receiving the attention it deserves; for, in deciding whether to employ an oil or a salt there are certain considerations, the neglect of any one of which may lead to the failure of the entire process. The necessity of adapting the treatment to the climatic conditions to which the material will be exposed, as well as for the purposes for which it is used, is now generally understood.

Of more recent date has been the recognition of the fact that salts can be profitably used when the density of the timbers renders the penetration of creosote extremely difficult, and that the preparatory processes should be adapted to each method of treatment. Some consolation can be found in the fact that dense timbers, if difficult to penetrate, are also slow to lose the preservative after treatment; thus, some species retain the antiseptic salt much better than others, and this variability is often seen in individual timbers of the same species; this partly explains the remarkable durability of certain ties over others of the same species and under similar conditions. It is also of direct value in deciding whether or not some chemical device should be employed to prevent leaching. I refer particularly to the use of such devices as glue and tannin in the Wellhouse process in preference to the simple Burnettizing. While the former has unquestionably been found of value in the treatment with zinc chloride of loblolly pine and other porous timbers in which the leaching is very rapid on exposure to the air and soil, the wisdom of its application to the denser species is open to serious doubt.

This matter of the leaching of the preservative after treatment has done more than anything else to discourage the use of antiseptic salts and the tendency to confine the treatment to insoluble oils is making itself felt to-day. But in the general advance in wood preservation which has been made, and which will be made in the future, at least for some time to come, salts must play an important part. As our knowledge becomes more generally disseminated, the soluble salts will find their true place in the industry and maintain it by their own worth. For, just as study has revealed new uses for creosote, similar results will follow the attention which the salts are now securing. The probability of this result is increased when we consider the abundance of the available supply, its comparatively low cost, its ease and safety of storage and the cheapness of its transportation. For oil shipped from the nearest source of large supply to Rocky Mountain points, the freight charges are as high as 12 cts. per gal.; thus rendering almost prohibitive any attempt at timber preservation unless some cheaper and lighter material can be secured.

THE FUTURE PRODUCTION OF CREOSOTE.—This question leads directly to the consideration. not only of what has been done, but of what must be done if the present progress of the industry is to remain unimpeded. It is only a few years since the coal-tar produced at gas works was either burned or destroyed. When the value of certain of its constituents was discovered, it was put on the market at a comparatively low price. But so rapid has been the advance of the timber preserving industry that the production of creosote has wholly failed to keep pace with the demand, until at present the price has greatly risen and is continually increasing. Therefore, if creosote is to maintain the place which it now holds, it is necessary that something should be done to stimulate its production and keep the price comparatively low. And this activity should not be confined to quantity alone, but careful consideration should also be given to composition.

When creosote first opened up a market for itself in this country the other coal-tar products were in less demand, and hence it was customary to include in it certain other and less desirable compounds. The presence of the antiseptic constituents still ensured the preservation of the timber, and hence little attempt was at first made to exclude the adulterations, and the specifications were made to fit the oil supplied by the manufacturer. Experiments which the Forest Service and others have carried on during the past year have demonstrated the necessity for a more exact knowledge of the part the different constituents fulfill, in order that the worthless may be separated from the really valuable constituents. The place which the other tar-acids as well as the lighter fraction of the napthalene series occupy in this highly complex compound as a wood preservative are better understood to-day than ever before, and as a result of our studies we expect soon to be able to draw up specifications which will insure the best oil for the different purposes. But until the production of creosote is increased, all specifications and all other efforts to advance the industry must prove of no avail, for at the present time it is often necessary to accept what is available, rather than what is most desirable. The large amount of tar which even now is being allowed to waste would seem to indicate that the production of creosote, even in its most impure form, cannot be a very profitable industry when considered by itself, and hence the manufacturer cannot be held too strictly to blame for the presence of undesirable constituents in his oils. But by the advancement of knowledge relating to the actual values of the different constituents of the oil apart from their use in wood preservation and by the stimulation of the demand for coal-tar products, much has been done to create a market for the other constituents of the distillation. During the experiments of the Forest Service, to which I have just alluded, the larger manufacturers of creosote in the United States have shown a gratifying interest and desire to co-operate in increasing our knowledge of this oil and thus stimulating such a demand for other coal-tar products that the price of creosote may be decreased. And in this cause I solicit the hearty cooperation of every one present here to-day.

But these are really minor difficulties and undoubtedly will be overcome by the same intelligence and energy which has advanced the industry of wood preservation in the United States so rapidly in the past few years. On the whole, it may be said that at no time have we had greater cause to look back upon the past with satisfaction and upon the future with expectancy. Theory unsupported by experience is no longer tempting us from the paths of steady progress, and at the same time the most experienced operators are glad to acknowledge their indebtedness to pure theory. We are thus on a firm working basis; we are in position to appraise new methods at their actual value for conditions in this country, and we can modify or adapt them without disturbing our own equilibrium.

FAILURE OF A 176-FT. REINFORCED-CONCRETE CHIMNEY AT LOUISVILLE, KY.

By D. R. LYMAN.*

On January 19, 1907, about 7.30 p. m., a portion of the reinforced-concrete chimney of the Seelbach Hotel, situated at Fourth and Walnut Sts., Louisville, Ky., fell. The accident occurred during a violent wind storm, which had been blowing all day, the maximum velocity of which was 42 miles an hour at the United States Weather Bureau, one block south of the hotel. The temperature was about 71°. The chimney was completed in the early part of 1905, since which time it has been subjected to stronger winds than that of Jan. 19, the highest velocity since its erection having been 54 miles an hour (on May 31, 1906). On the night of the accident the wind was from the southwest, on which side the chimney was entirely exposed to it, being only protected on the northeast side by the hotel building, which is ten stories high. Contrary to what might have been expected under these circumstances, the chimney fell toward the northwest.

FIG. 1. WRECKAGE OF 176-FT. REINFORCED CONCRETE CHIMNEY; SEELBACH HOTEL, LOUISVILLE, KY.

That suspicion of some sort was felt by persons in authority is evident. Prior to the accident a scaffold (part of which may be seen in Fig. 2) had been erected around the stack (but clear of it, according to attaches of the place) for the admitted purpose of attaching guy wires. A workman had gone up for this purpose on the morning of the accident, but was driven down by the high wind. The failure occurred several hours later.

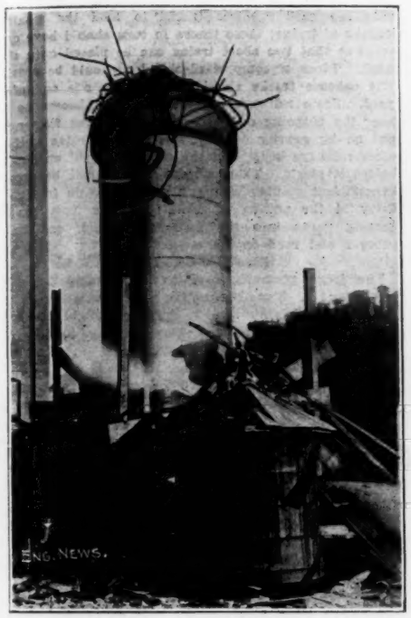
From the best information the writer could obtain (there being no detail drawings available), the chimney stood 176 ft. above ground; about 130 ft. projected above the boiler-house roof, about 25 ft. remaining after the accident. The lower 70 ft., of which the outside diameter is 84 ins., consists of two concrete shells 5 ins. thick separated by a 5-in. air-space. Above this section the chimney was a single shell 5 ins. thick, with an outside diameter of 64 ins. As nearly as the writer could determine, the vertical reinforcement at the plane of fracture consisted of about sixteen 1¼ × 1¼ × ⁸/₁₆-in. T-bars, arranged in pairs. The circumferential bars were 1 × 1 × ⅛-in. Tees, spaced about 2 ft. The vertical and horizontal bars were not connected at intersections, nor could any evidence be found of even an attempt at a mechanical bond.

It was at the lowest point of the 64-in. section that the chimney failed. From the appearance of the wreckage (Fig. 1), it is evident that the failure occurred on one line only, and that the structure above this line remained intact until it struck the earth and the roof on which it fell, when it was crushed flat and very badly shattered, there being scarcely any pieces larger than 1 ft. square.

*Louisville, Ky.

The concrete is composed of Portland cement and sand in about the proportion of 1 to 8 or 9. Both vertical and horizontal cracks are apparent. The writer has a sample about 2 ins. thick, taken from the wreckage, which he saw broken between a man's hands and knee, the break occurring along a vertical joint which first attracted the writer's attention to this particular sample. Portions of the concrete are so soft that it can be disintegrated by rubbing with the thumb, while numerous instances were found where pieces could be broken off bodily with the hands.

The interior of the collapsed shell is discolored to a depth of an inch, either by heat or the gases of combustion; but the concrete here is apparently no worse than the remainder. The bond between concrete and steel was entirely destroyed by the fall, only two instances being found by the writer where even small particles of concrete adhered to the steel in the wreckage. One of these was found on the ground, the other on the roof of the boiler room. Except in these two instances, the reinforcing bars were as free from concrete as if they had never left the mill.



FIGS. 2 AND 3. TWO VIEWS OF THE REMAINS OF A REINFORCED CONCRETE CHIMNEY AFTER FAILURE, SEELBACH HOTEL, LOUISVILLE, KY.
(Views taken looking northeast.)

The steel was entirely free from rust scales and very few bars were broken.

The outer shell of the standing portion of the chimney contains many cracks, both horizontal and vertical, some apparently extending at least an inch into the shell. The lines between the 3-ft. vertical courses are clearly marked (Fig. 2), and are not surface lines only, but appear to have been caused by imperfect bond between courses. The reinforcing bars project about 5 ft. above the line of fracture and are of fairly uniform length. They are not broken, but have pulled out of the concrete.

Assuming a wind pressure of 50 lbs. per sq. ft. on a normal plane, the compression in the concrete at the plane of fracture was about 480 lbs. per sq. in. This would be a rather high working stress for this quality of concrete, but in the writer's opinion not sufficient to have caused the failure. The fact that the vertical bars at the plane of fracture are not broken disposes of the possibility that the vertical reinforcement was insufficient. In the writer's opinion, the failure was caused by the breaking of the bond between concrete and steel on the southeast side of the chimney, which was weakened by the repeated strong gusts of wind during the day, and which failed before the ultimate tensile strength of the steel was developed.

It is reported that the contractors who erected the chimney will rebuild it without cost to the owners, and will also repair the damage to buildings caused by the failure.

THE COMPENSATION OF ENGINEERS.*

By J. D. BLACKWELL.†

The engineer is seldom paid in proportion to his talent or to what other professions are getting for work of like responsibility, and why? It is largely because the individual has not advertised to the world the value of his services, and because each individual has set his price regardless of the other fellow. Men who demand a fair compensation for their services are continually hampered with the smaller compensation somebody else is willing to accept for similar work.

In this connection one or two things should be mentioned that are sometimes practiced by engineers, and that undoubtedly hurt the whole profession. One is the seeking of information from manufacturers or agents in reference to engineering details which the engineer should work out for himself. It seems to me that a client must have little respect for an engineer's knowledge who says to him, so and so manufacturer says such and such can be done. If I were the client I would go at once to Mr. So-and-so Manufacturer and save the expense of Mr. Engineer. Another thing which is considerable of an evil in some Eastern sections is what is known as "P. J." work; in plain English, a man who is regularly employed in a salaried position, at no expense for office advertising or materials, taking work out of his regular office hours at rates lower than those current for such work. I do not want to be understood as objecting to a man doing all of such work that he can do where it does not interfere with the discharge of his duty to his employer; but when he begins to cut prices in order to get work he is doing a suicidal thing that will ultimately come home to him. He establishes a price which is used to regulate the charge of his employer, and as the employer is pinched the employee's salary is reduced.

Another practice common in the East is that of college students working during vacation time for extremely low wages. Considered from the student's point of view it may be a profitable business; he is learning, and if he can make expenses while so doing is ahead of the game. But he finds when he goes out in the world to take care of a family, that the engineer's compensation is too small, and he realizes too late that he has helped to make it so. I know of several concerns in the East that make a practice of putting by all the work they can until the vacation season, and from June to September they run 25 to 30 college men, paid from $1 to $2.25 per day, the higher figure being often received by men in responsible charge of work. I am told that in the East, the railroads and corporations within reach of the large technical schools can get all the men they want below the rank of Division Engineer for $75 per month.

I suppose if the question were put to each member of this Society what he considered a fair compensation for an engineer's services, you would hear figures ranging from $3 per day to $25 per day, and from $90 per month to $500 per month, or $840 per year to $6,000 and $8,000, or probably more. Now we recognize that there are different grades of men and different grades of work, and each grade would probably have in mind the compensation for its particular grade, and would naturally measure everything according to its standard. Now to people in general an engineer is an engineer regardless of what grade of work he does, and as the engineers themselves are nowhere nearly agreed as to their compensation, they cannot expect the public to do anything except endeavor to get every one at the figure of the lowest, no matter what the grade of his work is.

Coming down to facts and figures, I am going to give scales that I think are fair, and I would like to hear a few opinions on them and endeavor to get fixed in the minds of all a basis of arriving at a compensation. First of all, I think it is thoroughly unprofessional to bid a lump sum for doing any kind of work, and I would like to hear of this Society going on record as opposing it and discouraging it as much as possible.

Second, I believe the scale of compensation fixed by the surveyors in Chicago, December 26th, 1891, is about right for minimum surveyors' charges in Seattle to-day. The scale is as follows:

Staking out ordinary house lot, including street grade.	$18
Staking out ordinary house lot, without street grade..	15
Giving street grade alone	10

Subdivision into lots in open country, plain rectangular work on cleared and level land:

5 Acre Tracts, per acre	$7.00
10 " " " "	5.00
20 " " " "	4.00
40 " " " "	3.75
80 " " " "	3.25
160 " " " "	3.00
Surveying party by the day, party consisting of three men	25.00

Surveys are guaranteed correct, and the surveyor to indemnify the owner for all mistakes.

The City of Seattle when called upon to establish corners and give grades on a lot in the downtown district for private individuals makes a minimum charge of $25. but if the work is later checked, it charges $40 or $50.

Engineering services, other than straight surveying, can usually be put under one of the following two heads. Work impossible to apply fixed rates to—such as reports, on projects, court work, investigations into projects, lining up projects, and so forth, in which the compensation is dependent upon the amount of work and the amount of skill and experience required to do the work. This class of work in most cases is such that it should not be done for less than $25 per day for the individual doing the work; it is the class of work usually considered under the head of expert or consulting. The other class is what you might call structural or the work of the constructing engineer, and consists of the design and supervision of buildings, plants and projects, and for this grade of work the following, taken from Engineering News of last year, seems reasonable:

Full professional services, including active superintendence and management	10%
Full professional services, including general supervision	5%
Preliminary study	1%
Preliminary study, including general drawings and specifications	2½%
Preliminary study, including detail drawings and specifications	3½%

Commission computed on entire cost of work, traveling expenses to be paid by client.

A WATER METER SYSTEM FOR WATERBURY, Conn., has been recommended by William E. Kennedy, Superintendent of Water-Works of that city. Mr. Kennedy recently made an extensive report on meters and meter rates for Waterbury. He points out that if the consumption is not reduced it will be necessary to build another large reservoir soon, at a probable cost of something like $1,000,000. This fact, combined with the construction of a sewage purification plant by the city, makes it highly desirable that the consumption be reduced. Regarding water rates, Mr. Kennedy states that the present rates were made when the water consumption was small and few meters were in use. The rates were intended to encourage taking water by a flat or schedule rate, rather than by meter rates. At the time they were adopted the city had no sewerage system, and consequently water waste was generally productive of more or less trouble. In arriving at a proper meter charge for the present date, Mr. Kennedy takes into account the reduction in consumption that may be expected to follow the introduction of meters, and also makes calculations as to the amount of water used for various city purposes. He concludes that in order to raise the necessary revenue a meter rate of 7 cts. per 100 cu. ft. should be adopted. This is just one-third the rate now paid by the majority of metered consumers. A minimum rate of $5 per year is suggested as the lowest to be permissible under the circumstances.

*Extract from presidential address at the fifth annual convention of the Pacific Northwest Society of Engineers.

†Of Hanford & Blackwell, Engineers, 1101 Alaska Building, Seattle, Wash.

THE DESIGN OF RAILWAY FREIGHT TERMINALS.*

By H. M. NORTH.†

The design of a terminal yard must be adapted to the rapid and economical movement of cars for the forwarding of traffic; but these requirements are not fulfilled in the majority of terminals examined by the writer. The time of ordinary freight through a terminal yard should not and need not exceed four hours, from the time of receipt until departure. Expedited freight can readily be put through in one hour's time; and freight that must be transferred, rearranged, shifted or otherwise given extra handling, should not be detained more than 12 hours. These requirements as to time are not only essential for economy, but for the conditions of competition as well.

The cost of moving freight through terminals can be held down to less than 15 cts. per car for all operating charges, including breakage of cars. The actual cost per car on the same basis in the average yard probably approximates 30 cts. The difference between these two figures is the saving that efficient design of trackage, grades and facilities effects.

The bulk of work in a freight terminal yard is the separating or classifying of cars. This is accomplished by switch-engine service in some one of several ways. The ordinary method of pushing and pulling, or as it is more commonly known, the "kicking" method, is the best known. It is adaptable to almost any lay of ground, costs the least in first construction and within the limits of effectiveness, when well handled, a yard so designed does excellent work.

The "poling" method has been used as an improvement on the "kicking" method, to lessen the damage claims, and damage to cars, as well as to increase the capacity of the yards. It requires an extra track parallel with the ladder to which the body tracks of the yard connect; its first cost is accordingly somewhat greater than that of a kicking yard, and it demands more favorable ground than the latter. It will handle about 100% more traffic than a kicking yard, at a somewhat smaller expense per car, if well handled. The almost irresistible tendency is to attempt to handle poling yards with an insufficient force of switchmen, and the resulting breakage of cars and contents has reacted against this general method of switching.

The application of the power of gravity to give cars the forward movement to carry them into their respective classification tracks, has developed sufficiently so that it may be confidently stated that this method is the best and the only one, so far attempted, which will handle heavy business speedily, economically and satisfactorily.

There may be said to be four principal handlings of freight cars and one auxiliary handling of a portion of them, involved in the movement of all traffic through a freight terminal. The occasional solid train that goes through with no change in its make-up except to change engines, cabin cars and crews is an exception. These handlings are: (1) The receiving of incoming trains and the work incidental thereto. (2) The separating or classifying of cars, more commonly known as "breaking up" trains. (3) The grouping into train order for advance movement, of the separated or classified cars, commonly known as "making up" trains. (4) The forwarding of trains, and the work incidental thereto. The auxiliary work comprises the rearrangement, consolidation and transfer of freight for reasons of economy, safety, or because of the need of repairing the cars; the icing of perishable freight, or the feed, water and rest needed by stock.

RECEIVING YARD.

This yard, for receiving the incoming trains, should have tracks of a sufficient length to admit the maximum length trains that can be anticipated, without doubling in. For this estimate, a car's length is assumed at 40 ft., and engine's length at 75 ft. In addition there should be several hundred feet of leeway for double-header trains and for inexact stopping of trains. As there will be many short trains, these long tracks should be provided with a reasonable proportion of crossovers to thoroughfares, so that a train will not block the entire length of a track. Also, as a number of trains have cars of perishable or live freight directly behind the engine, trackage outlet independent of the regular outlet of the receiving yard should be provided to afford a direct and immediate movement to the icing plant or stockyard.

The time of a train in a receiving yard under average conditions should not exceed one hour, for the purpose of cutting off the road engine and the caboose, the inspection of cars for defects, and the coupling on of the switch engine in readiness to commence breaking up the train. This time can be used for making light repairs to cars, and in certain large yards about half of the defective cars are repaired during this period. This is accomplished by stationing a squad of car repairers at intervals along the track the train is entering. This work can be done with the tracks 13 ft. c. to c., but where there is space available 14 ft. spacing is preferable. The number of tracks in such a yard should be sufficient to hold the accumulation that may result from any likely derailment in the advance movement through the general yard system, or congestion from other causes.

There are always cars without way-bills, cars of unconsigned lumber and unconsigned coal, to be held for billing at any terminal. These cars should never be allowed to block a receiving yard. Their forward movement is ordered day by day, a car or more here, and a car or more there, from the strings of cars on the "hold" tracks. It is manifestly bad operating policy to handle long strings of cars to secure an occasional car. Accordingly, there should be placed alongside the receiving yard, a sufficient number of moderate length "hold" tracks, which can be switched by the push-and-pull method. The writer makes it a practice for the usual coal hold yards to equip each four body tracks with an independent ladder drill track at each end. There will, of course, come times when a sufficient number of billing orders arrive, to justify classifying an entire string of cars from a given track; the proper trackage for such a contingency should be provided.

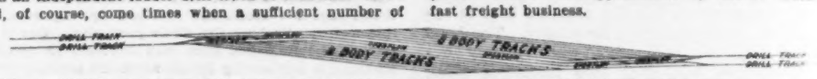


FIG. 1. UNITS OF TYPICAL YARD FOR SWITCHING BY THE PUSH-AND-PULL METHOD; EIGHT BODY TRACKS TO EACH LADDER.

(Adapted to points where six classifications will usually suffice in making up trains.)

SEPARATING OR CLASSIFYING YARD.

When solid trains of through freight come into a yard they can go onward as received after inspection, change of crews and incidental work, without being broken up. For this class of trains a by-pass line from the receiving yard to the forwarding yard should be provided. Nearly all trains, however, contain cars of local freight or of interchange freight for other railway lines; and cars of company supplies, bad order cars and improperly loaded cars are usual. Different ruling grades or motive power assignment on the next division, may require the train lightened or filled out. The yard may also be a junction for diverging lines of the railway, and trains will usually have freight for each line. For these reasons, the cars of an incoming train must be separated, assembling on separate tracks the cars for destinations or classes of yard work. For this separation work, there is required such a number of tracks as the number of classifications suggest, after considering the influence of acceptable operating demands, the yard space available, the second switching needed and local conditions.

The separating yard should be designed so that, so far as possible, all the separating of different cuts of cars be accomplished when first dropping them into the separating yards; and at the outlet end of the separating yard, the work so far as possible should be only that of bunching together these groups of cars from the different tracks into a train lot. In spite of the most favorable design, a certain amount of second switching at the outlet end of the separating yard is necessary to put cars into train order. Where this amount is small, it can be accomplished by the push-and-pull method by providing the outlet end of the body tracks with a good ladder drill system so that engines can work simultaneously without delaying each other. If this "tail switching" aggregates a considerable amount of the traffic or must be done quickly, the cars should be taken to a second separating yard, more properly called a "grouping" yard, or classifying yard, where the grouping into train order can be done without interfering with the functions of the main separating yard. This latter grouping yard is particularly needed where there is a large proportion of fast freight to be handled.

The length of the individual tracks in a separating yard is usually made equivalent to a maximum train length, but the writer believes that in nearly all cases such tracks should be of about 60% the length of maximum trains, except as noted below. This belief is based upon the unfavorable working of long tracks in existing yards and upon the following theory: a classifying or separating yard is not a storage yard, nor should it be so used in any part, as such use blocks the particular tracks from receiving additional cars, as the work of separation proceeds. That portion of the traffic that is held for bills or is unconsigned should be moved to a "hold" yard, as earlier outlined. All other freight should be separated, made up into trains and forwarded as a continuous movement, for the better use of the equipment, the speedier forwarding of freight, and the smaller force of yard men thereby required.

The exception in regard to length of tracks, noted above, is where traffic is so regular and heavy that a maximum train length of cars which require no grouping into train order, can be expected to accumulate within the time limits that such cars can properly be held before forwarding. This proviso should be distinctly considered, for this feature has often proved a stumbling block in a yard design.

There are only a few railways in this country whose business at the largest gateways is so heavy as to justify the adoption of the above exceptions. At St. Louis, for instance, the Gould system handles about 9% of the total aggregate business of the 23 railways entering that important gateway; nevertheless, the rapid forwarding of cars demanded by the conditions of competition absolutely forbade any construction of long tracks in the separating yards to hold accumulations of cars for the same destination. Accordingly, the separating tracks at the Dupo yard (noted further on) were established at 35 car lengths each, basing this upon a train length of 60 cars as the maximum advisable for belt-line movement. At Buffalo, the slow freight of the Vanderbilt system accumulates rapidly in train lots, with practically no train-order work needed; accordingly, certain tracks were provided to hold 100 cars each in the separating yards. These are supplemented by shorter tracks for fast freight business.

FORWARDING YARD.

When a train is made up, it is taken to the forwarding yard where the air brakes are tested and coupled together, the caboose and road engine coupled on, and it moves forward on its way to destination. For this purpose the yard requires tracks to hold the maximum lengths of trains; these tracks in turn should have crossovers so that two short trains can be placed on a single track. Lines of compressed-air pipe should be provided. The caboose tracks should be close to one end of this yard. Some railways prefer that the cabooses be kept near the outgoing end of this yard, so that they can be put on by gravity or otherwise as the trains pull out; other railways insist that the caboose be put on the train before it starts. Thoroughfare tracks must be provided in sufficient number so that there can be no friction nor delay in the pulling of made-up trains from the separating yards into the forwarding yard, and in the caboose and road engine movements.

FROGS FOR YARDS.

The frogs generally used in yard tracks have been Nos. 6 and 7. Since the motive power departments began flanging all driving wheels, and the weight of engines has increased so much, the sharp leads required by these short angled frogs have been expensive and difficult to maintain, and derailments much increased.

In a terminal yard where switching is constant, no frog of lighter angle than No. 8 should be permitted, and this only in the portions where the work is done exclusively by yard switch engines. The yard and road engines of the present day will frequently derail on a No. 8 lead in perfect condition. In the receiving and forwarding yards, where the road engines must move, and in the approaches to the humps of gravity yards, the frogs should be No. 9 at the lightest and No. 10 if practicable. The enormous engines used for hump engines are very destructive of switch leads and will derail frequently on sharp leads. In the ladder leads of separation yards operated by gravity, the curvature of the switch leads must not be such as to bind the cars running around them; a No. 8 frog is the sharpest justifiable, and No. 9 is preferable. These general rules as to frog angles may seem hard to follow on a given strip of land; but the evil of their disregard is certain. The writer makes it a practice to make the diverging angle of the body track as large as possible and carry the curve beyond the frog to make up the total central angle.

LADDER TRACKS.

Ladder leads should be adapted to the needs and use of the body tracks they control. They should be as short as business permits, and the body tracks that one ladder cannot well control should be coupled to another ladder. It is generally conceded that a single switch engine cannot economically switch more than eight tracks. This rule would make that number the maximum number of body tracks to couple into a single drill track. Fig. 1 shows a combination of three units of eight tracks per ladder, illustrating the simplest type of classifying yards. In such an arrangement three engines could be switching continually without friction. Before accepting the above rule as conclusive in a given case, the number of separations required to put a train into proper order for forward movement must be considered. If there are more than six groupings required, and only eight tracks provided, a corresponding amount of temporary bunching and re-switching will be necessary.

Conditions often require 15 to 20 classifications to make up cars into train order, and these conditions must be met satisfactorily, if economical and efficient work is to be secured. At such points, if the separation work is to

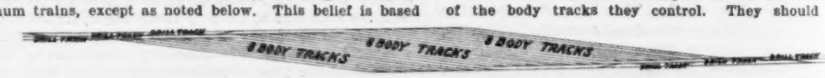


FIG. 2. TYPICAL YARD FOR SWITCHING, WITH EIGHT BODY TRACKS TO EACH LADDER.

(Adapted to points where more than six classifications are required.)

*Abstract of a paper read before the Western Society of Engineers, at Chicago, Jan. 23.

†Assistant Engineer of Construction, Lake Shore & Michigan Southern Ry., Cleveland, O.

be handled by the push-and-pull method, two drilling leads can be designed with half the total number of classification tracks needed, coupled to each ladder. Between these two tracks should be placed two receiving tracks common to each drill track. Upon these special receiving tracks can be placed the overflow groups from one side that are to be later grouped on the other side, and vice versa. This, of course, means re-switching, but there is no better solution of this difficulty, and the usual custom is more disadvantageous. Fig. 2 shows a combination of two units of eight tracks per ladder with the two common tracks between for receiving the overflow cars from either side to meet such conditions.

These two cuts show the arrangement of drilling lead and body tracks of these simpler types of yards, to be embodied in the design of a small yard for a particular point. These give eight tracks as the advisable number on a single drill track. Such an arrangement makes one body track a receiving track, another body track the forwarding track upon which the new train is made up, and assigns the other six tracks for the classification work.

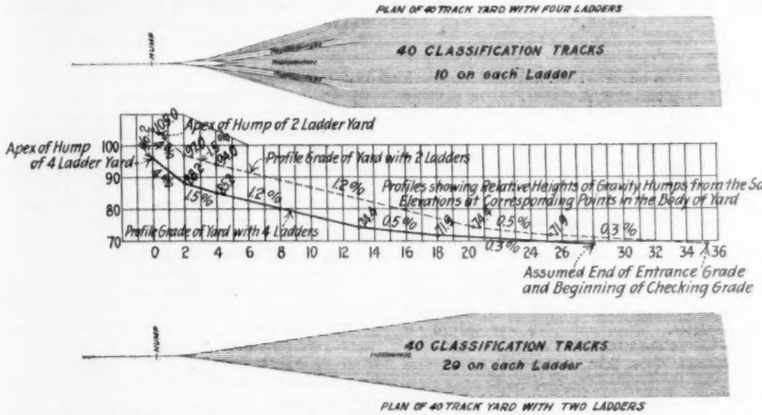

PLAN OF 40 TRACK YARD WITH FOUR LADDERS
40 CLASSIFICATION TRACKS
10 on each Ladder
Apex of Hump of 2 Ladder Yard
Apex of Hump of 4 Ladder Yard
Profile Grade of Yard with 2 Ladders
Profiles showing Relative Heights of Gravity Humps from the Same Elevations at Corresponding Points in the Body of Yard
Profile Grade of Yard with 4 Ladders
Assumed End of Entrance Grade and Beginning of Checking Grade
40 CLASSIFICATION TRACKS
20 on each Ladder
PLAN OF 40 TRACK YARD WITH TWO LADDERS

FIG. 3. PLAN AND PROFILE OF 40-TRACK GRAVITY YARD ARRANGED FOR THE TWO-LADDER AND FOUR-LADDER METHOD OF SWITCHING.

In the hump yard system, the above rules do not obtain in the gravity portion of the separating yard. Here the motive force that starts each car and moves it forward into and partly through the separating yard, is gravity only; the only work required of the switch engine to effect the separation of the cars is to push a train up to and over the apex of the hump. If the track arrangement and adjustment of gravity ratios beyond the apex are properly designed, the cars will run over a single track throat into the respective tracks of the separating yard faster than it is physically possible to bring them to the apex by the most advantageous track arrangement. Accordingly, there is no object in providing more than a single track throat to such a yard. The usual difficulties with gravity separation yards are due to improper adaptation of gravity, sharp switch leads and unnecessarily curved ladder leads, which cause the cars to bind and either lag or entirely stop before reaching the right point. Also, excessively long ladders which call for high humps, slower movement of trains, greater forces of riders and other evils.

The track arrangement should be based upon coupling to a single ladder not more than ten tracks in the very largest yard, and not more than six tracks, if possible, in other yards. If a given hump yard is to have 24 tracks, four ladders each with six tracks coupled would be required. If 30 tracks are needed, it would be better that eight tracks each be coupled to two ladders and seven each to the other two ladders, as it is seldom advisable to put more than four ladders in a yard, owing to the extra curvature involved in the tracks from the fifth and sixth ladders. This arrangement of four ladders is shown in Fig. 3 in comparison with two ladders for the same number of body tracks, and a profile for each, all drawn to the same scale and for similar operating conditions. The advantage of the four-ladder scheme is manifest.

TRACK SCALES.

There are few questions in yard design more annoying than the proper location for the track scale. At terminal points, where large yards are needed, there is usually a considerable proportion of the total business to be weighed. If this percentage justifies it, the scales can be placed on the hump alongside of and parallel with the regular entrance track to the separating yard, so that the trains containing weigh cars can pass over the scale as they enter the yard. This is the quickest method of weighing. It is, however, a distinct misfortune to all other traffic to place the scales on the hump, as the adjustment of gravity ratios to properly move cars for weighing is not the most advantageous for other freight.

Cars can be weighed satisfactorily to the weighing associations, while running free, at the rate of about four a minute, but the interruptions to work are so continual as to cut the daily weighing down. On the other hand, the grades that are suitable for a plain throat track, free from scales, will permit the classification of cars faster than it is possible to bring them up the hump. The writer has seen 11 cars per minute classified over a well arranged hump until the car supply gave out, and from average results from several yards it is safe to count on an average of 3,000 cars per day of 20 hours as readily possible, even under adverse conditions, with an ordinary force of riders, and no special effort. These conditions urge one to attempt to locate the scales elsewhere than on the hump.

In developing plans for the Buffalo terminal yards of the New York Central Lines, to be located at Gardenville, where the proportion of cars to be weighed was unusually small, the following scheme was developed: For heavy runs of weigh cars, a scale was placed at the mid-length of an independent track, extending outside of and alongside the general separation yard from its outlet backward to the receiving yard. The weigh cars collect on a particular track in the separating yard up to the capacity of an engine to handle readily. They are then pulled out from the separating yard, and pushed backward to the scale track, and weighed as they move over the scale towards the receiving yards. When weighed, they are pushed to the entrance to the hump, ready for reclassification for destination. The easiest way to reclassify is, of course, by gravity, and the cars are in the correct place for moving over the hump for this purpose. The backup movement involved in this scheme of weighing is unfortunate, but is a much less evil than is involved in placing the scale on the hump.

For comparatively light business, a distinct improvement in the above scheme for weighing was suggested for the Buffalo terminal by Mr. R. O. Rote, Principal Assistant Engineer of the Lake Shore & Michigan Southern Ry. The scale was placed at the mid-length of the outside body track of the general separating yard, and the particular gravity ladder running from the throat of the yard to this track was connected to a thoroughfare track by a trailing switch. After the upper ends of the gravity scale track was filled from the scales to this trailing switch, a yard engine ran through to the cars, pushed them over the scales, then reversed, pulling them back, via the outside thoroughfare around the hump to the receiving yard, and reversing again, pushed them over the hump. This movement interferes slightly with yard operation, but can usually be performed to fit in with other work smoothly, and for such amounts of business as it can handle, it is distinctly the best arrangement known to the writer.

LIGHTING YARDS FOR NIGHT OPERATION.

Yard work is dangerous, difficult and slow, during the hours of darkness and during fog. Electric lights are frequently used for yard illumination, and the switchmen supplement these by leaving a lantern on the ground opposite the end of the last car on each track. The electric lights, as ordinarily used, are not effective, and the cars are handled slowly as a result. The defect of these lights is due to their dimness, the lack of sufficient number, and their ineffective placing.

To overcome this trouble on the humps and ladders, Mr. M. E. Shire, Engineer-in-Charge of the "Clearing Yards" at Chicago, has developed a device like the reflector of a locomotive headlight; each light is equipped with one of these, and it is placed so that the rays of light are directed toward the important channels of the work. The classification yards are most in need of such a lighting arrangement, and as there are no reverse movements in this yard, not even the slight disadvantage of lines of clear light shining at times in the faces of the switchmen is experienced.

While all portions of the yard system should work smoothly and without delay, the work is concentrated at the entrances and on the ladder leads of the classification yard, as all cars must enter the yard over a single throat track and go to their respective destinations by way of one of the ladder leads. Furthermore, the momentum required to start the cars and carry them well into the classification yard must be imparted by the grade of the throat track and ladder leads. Consequently, the maximum speed of the car occurs in its movement over the ladders, and if this speed is checked by the brakes by the rider, because he cannot see the car ahead of him clearly enough to judge of its relative position and speed, the capacity of the entire yard is thereby affected. There are no yards as far as observed where this lack of sufficient light does not lessen the operating capacity during the hours of darkness.

For lighting the ladder lead of the classification yard, one or more of these lights with reflectors is placed at proper intervals from the hump to the ladder end, on poles or on steel bridges. The height must be sufficient to avoid casting serious shadows from one car to another, and the reflectors properly trained to throw the rays of light where needed. In the body of the classification yard these lights are needed in greater quantity, and arranged to sweep the yard at different angles; on the outlet ladders, and in the other yards of the system, this type of reflector is undesirable, as the switching is equally backward and forward in direction, and movement toward the lights would be blinded by its rays. Accordingly, the effective arrangement in these places is a general diffused light reflected downward only.

For the Dupo yard of the Gould system there has been developed under the writer's direction, a similar system of conserving and reflecting the rays of light to the points where they are needed. A special reflector was developed by the General Electric Co., in place of the locomotive headlight type, and the reflecting surface was of porcelain enamel on thin sheet steel. The lights were carried on systems of general current-bearing lines of not greater than 440 volts, so arranged that the breakage of a single line would plunge only one part of the yard

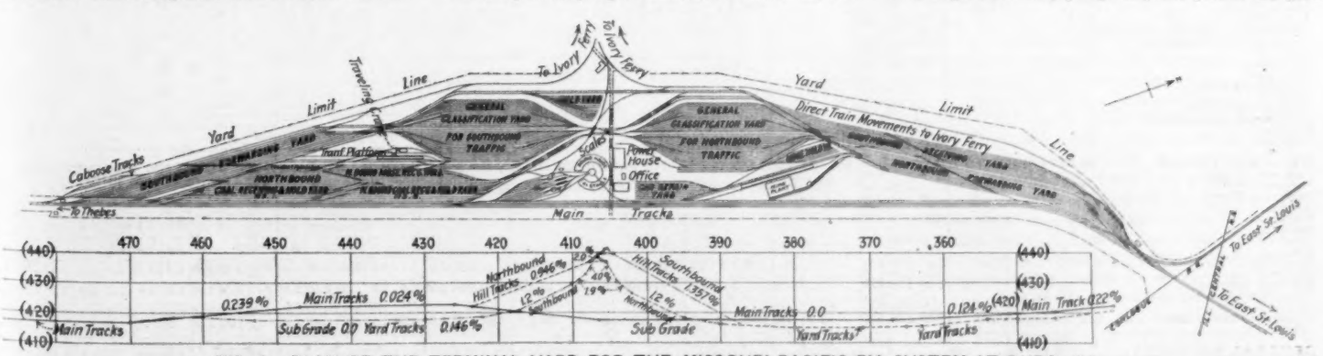


FIG. 4. PLAN OF THE TERMINAL YARD FOR THE MISSOURI PACIFIC RY. SYSTEM AT DUPO, ILL.
H. M. North, Designer. E. F. Mitchell, Engineer of Construction.

in darkness. This scheme makes its first cost, maintenance and repair economical, and minimizes both the danger to employees and the amount of interruption to work due to breakage of wire lines.

TERMINAL YARD AT DUPO, ILL.

Fig. 4 is a plan of the terminal yard designed by the writer for the East St. Louis territory of the Missouri Pacific Ry., the St. Louis, Iron Mountain & Southern Ry., and the St. Louis Southwestern Ry., and for the incidental use of the Wabash Ry. This yard is now under construction, practically all the grading being complete, and a considerable portion of the track laid. Portions of the yard have been in use since Oct. 1, 1905. About half the trackage called for on this plan is to be built as the first installment of the terminal, the balance being provision for the future. This plan is submitted as the writer's idea of the application of the principles of yard design, for the conditions prevailing in the East St. Louis territory.

SUBDIVISION OF COST OF FIREPROOF CITY BUILDINGS.

An interesting set of figures relating to the cost of city buildings, compiled by Mr. F. J. T. Stewart, of the National Fire Protection Association, is published in a recent bulletin (No. 124) of that body. The figures show the relative costs of the various items entering into the make-up of the buildings. Separate sets of figures were obtained from five cities, and for five different types of building: office buildings, mercantile buildings (stores, salesroom or loft buildings, and the like), warehouses, schools and storage warehouses; all, of fireproof construction however. These figures, expressed as percentages of the total cost of the building, are tabulated as herewith.

The following explanatory notes on the table are also taken from the bulletin mentioned:

As the analysis of the cost of construction was not uniform for all data received, some difficulty was experienced in an attempt to show a complete comparison. Thus, in some cases, the cost of Foundations has not been given, and is probably included largely under Mason-Work. The comparison is, however, practically complete, in most cases, as far as the five general subdivisions are concerned.

Each column of figures in the table represents the data for an individual building, except the figures for New York, in the second, third and fifth columns, which show the average for a large number of buildings.

Comparing those cases in which a figure for cost of foundations appears, we learn that the foundations may cost as little as 2.3% and as much as 24.5% of the total cost of the building. In view of the great differences of soil conditions affecting different buildings, such a variation is to be expected. But above the foundations, buildings in different localities or different cities are very closely comparable, and the comparison is altogether unaffected by the nature of the foundations. It would give a fairer comparison, therefore, if the percentages were computed on the basis of cost of building above foundations as the unit. To do this from the figures given in the table would, however, be rather unsatisfactory, because the cost of foundations is given in but little over half the total number of cases, and because it seems probable that the figures given do not all represent strictly similar subdivisions.

TIE-PLATES AND TIE-RODS IN STREET RAILWAY TRACK.*

By E. P. ROUNDEY.†

Our attention was first called to the inefficiency of braced tie-plates as a means of holding girder rails to gage, when the cars on several of the lines in Syracuse began to leave the tracks; and in every case we found the track in the neighborhood of the place of derailment to be from ½-in. to 1-in. wide in gage. The track consisted of 9-in. half-grooved Lorain rails; 6 × 8-in. oak ties 8 ft. long, with 6 ins. of coarse gravel ballast, and malleable iron brace-plates every 6 ft. The concrete for the paving, which is both brick and asphalt, extends from the bottom of the tie to about 4 ins. above it. The track has been down about ten years.

The derailments became so numerous a short time after putting some new heavy cars on the lines, that we decided to place tie-rods in all of our tracks having the groove rail and brace-plates. When the track was opened for the tie-rods we found the ties in fair condition, but many of the brace-plates were bent backwards and others twisted away from the head of the rail, being practically of no use for holding the rails to gage. The track had been gradually widening out under the small cars and when the large heavy cars were run, it took only a short time to widen the gage until the track was unsafe.

Tie-rods have now been placed in most of this track and we have had no more trouble with derailments. The great objection to brace plates, judging from our experience, is due to their being spiked to wooden ties. They are dependent for their efficiency on the holding power of the spike, and as the ties get old the continual tipping of the side-bearing rail loosens the spikes, and allows the brace-plates to twist and become loose. They also cut into the ties as the wood decays, thus allowing the rail to tip outward. A great deal of care should be taken when putting on brace-plates, as the spikers will often twist them when spiking and get a poor bearing under the head of the rail. Crooked or uneven ties will also make trouble in getting a good job.

We have some steel brace-plates on a piece of track which has been down for about three years and have had no trouble as yet, but the cars are small and run at 10-minute intervals. When this track is to be paved we shall place the tie-rods 6 ft. apart in addition to the present brace-plates. The use of brace-plates would be advisable in laying track in an unpaved street, which should be paved in a few years, as a strong steel brace should hold the track when the ties are in good condition, and when the street is paved we should put in the tie-rods.

The objection to tie-rods in an unpaved street is that, as the filling between the rails settles, the rods are exposed to wagon traffic and bent or broken. The theoretical objections to brace-plates as compared with the tie-rods are as follows: The brace-plate depends for its efficiency on the condition of the tie, and braces each rail independently; if the braces on one side fail the gage will widen; with the tie-rod, if the rails get out of line, they will move together and maintain the gage. On ordinary girder-rail track a ½-in. widening of the gage will not cause derailment of cars, but with the half-groove type (especially our Lorain section) it will cause trouble much more frequently. The lip on this rail is thin and narrow, and flattens down under wagon traffic, often breaking off in places. When a car comes to a place where the gage is widened ½-in. or more, the flanges of the wheels on one side get inside of the lip of the rail and when the track comes to gage again the opposite wheels are forced over the head of the rail, causing derailment of the car.

With this type of rail to contend with, necessitating tight gage for safety, tie-rods are the best fastening. If a strong steel brace were used in connection with a steel tie, it should make an efficient device for holding the rails to gage.

There is not much to be said in favor of the use of ordinary tie-plates on rails in a paved street, as the concrete between the ties will support the rail, and keep it from cutting into the ties to any appreciable amount. However, the concrete in the older tracks in Syracuse does not seem to be of any use for holding the rails to gage, as spreading has occurred as stated above.

*Abstract of a paper read at the Buffalo meeting of the Street Railway Association of the State of New York, Jan. 11, 1907.

†Engineer of Maintenance of Way, Syracuse Rapid Transit Ry., Syracuse, N. Y.

TABLE SHOWING PROPORTION OF VALUE IN THE VARIOUS ITEMS OF CONSTRUCTION OF FIREPROOF BUILDINGS.

	NEW YORK						CHICAGO							BOSTON																				BALTIMORE								ST. LOUIS	
Occupancy	Ofcs.	Ofcs	Hotel	Ofcs	W. H.		Ofcs.	Ofcs	Ofcs.	Ofcs	Merc	Merc		Ofcs.	Ofcs	Ofcs.	Ofcs	Ofcs	Ofcs	Ofcs	Merc	Merc	Merc	Merc	Merc	Sch'l	Stg.	Merc.	Merc		Ofcs.	Ofcs.	Ofce	Ofcs.	Ofcs.	Ofcs.	Ofcs.	Ofcs.	Ofcs	Ofcs
Height in stories	10			12										9	11	10	10	11	11	11	11	7	4	6	3	5	3	7	5	6	11	12	7	14	9	8	10	7	12	12
Cost, cents per cubic ft.				40			30	3	34	8	32	3		14		23	6	34		35	49	67	41	8	45		34			14		21.5	22		29		29.6																		
FOUNDATIONS							4	4	2	34	5	67		6	00	10	74	10	6	5	13	4	32	7	5	4	42	5	8			14	2	14			11	5	13	5	7	4				24	5					5	62	4	37	7	25					4	3	5	7
Excavations and Back Filling																																																			1	22	1	25	2	07					4	3		
Shoring Banks, etc.																																																				1	06								
Foundation Footing and Concrete																																																		4	4		74	5							
Rubble Stone and Granite Pier Caps																																																				68							
Sidewalks and Curbs																																																				13		18					
STEEL FRAME	24	0	18	4	16	0	22	50	36	5	19	70	14	0	11	86	10	6	27	6	38	66	14	4	27	4	22	5	15.		25	7	21	8	21	4	24	6	8	25		2	2	22	1	19	32	14	65	21	2	21	6	14	3	7	95	13	6	14	54	19	52	9	9	9.	10	1	11	4	17	5	15	0	15	0
Material																																																					11	79								
Erection																																																				1	79								
Shop Drawings																																																				49								
Painting																																																				24								
Teaming																																																				32								
MASON WORK	26	56	26	2	31	5	20	10	32	52	6	31	27	96	22	3	38	5	27	6	44	79	40	4	15	0	32	23	41	6	33	60	27	57	34	85	26.		33	65	31	45	22	88	30	6	17	42	30	46	65	62	26.		38	6	23	76	28	5	34	15	30	15	31	31	37	2	29	9	35	5	20	0	25	0
Brick—Common																																																					27	5	8	3	18	9	15.												10	1	6	59	11	21.						8	98	13	5						
Brick—Face or Pressed																																																																				1	82	1	26																		
Brick—Enameled																																																																					86																					
Brick—Cleaning and Pointing																																																																					21																					
Terra Cotta			1	41					2	06			10	04			5	76																		

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Buying crude oil from the producers at 1 ct. to 3 cts. per gallon and selling the refined product to consumers at 10 cts. to 20 cts. per gallon is the business by which the Standard Oil Co. has accumulated larger profits than have ever been reaped by any organization in the world's history. We print in another column of this issue extracts from the recent report of the Inter-State Commerce Commission on its investigation of the Standard Oil Co. The report makes clear the methods by which this concern has been able for so long to retain its enormously profitable monopoly, and ruin those who have attempted to compete with it.

In any other industry, when profits exceed a normal rate, competition arises to lower the prices to consumers and raise prices to producers. Our whole social system, in fact, is based on the existence of free competition, and no principle of the common law is better established than that which asserts that contracts in restraint of competition are against public policy and void. In other industries, fair competition is recognized and accepted as a normal condition. In the oil business the long-established policy of the "Octopus" is to bring about the ruin of any concern which dares to compete with it.

It is noteworthy that the Standard's chief weapon against its competitors has been its control of transportation routes. The railways have poured millions into its treasury with one hand and robbed its competitors with the other. The transportation of oil by pipe line was, from the engineering point of view, a great advance; but the economies of this method have inured to the sole benefit of the Standard Oil Co. More important still, the pipe line system which the company controls has so intrenched it against competition that it can now, if it chooses, live an outwardly righteous life and still retain its monopoly and enormous profits.

How can the States or the Nation so deal with this aggregation of capital as to protect the public from indefinite further extortion at its hands? How can the private citizen, confronted with the demands of many other corporate monopolies, be given a square deal, and a fighting chance, at least, for life, liberty and the pursuit of happiness?

Perplexing as these problems are, every intelligent and far-seeing man realizes that a solution for them must be found or we shall be submerged in a wave of socialism. Standard Oil Co. methods have made more converts to socialism than all the writers on economic theories and all the yellow journals. The real conservatives of the present day are those who, like President Roosevelt, are working for intelligent supervision and control of monopolies by the Government. The manifold difficulties are freely admitted, but there is no other way out. The "Laissez Faire" system may be ever so eloquently advocated by the corporation agents; but they cannot convince the man being ground between the upper and the nether millstones that Government should not interfere to save him.

The gross pollution of the White River, above and below Indianapolis, Ind., shows what may be expected where great manufacturing industries spring up in a state which is virtually without regulation of stream pollution. Mr. Robert L. Sackett, Professor of Civil Engineering at Earlham College, Richmond, Ind., has made a sanitary survey of the White River for the Indiana State Board of Health. Some of the results of this survey were presented by Professor Sackett to the recent convention of the Indiana Society of Civil Engineers and Surveyors (see Eng. News, Jan. 24, 1907; p. 114). By far the worst pollution, at least in volume and in rank offensiveness, comes from various industrial plants. Under a proper system of sanitary protection of the waters of the state these plants would be required to treat their wastes before discharging them into the river, as probably would some of the towns that pollute the stream. We are glad to note that Professor Sackett, in his new position of Sanitary Engineer to the Indiana State Board of Health, has made as good a beginning as this sanitary survey of the White River indicates. Such work is bound to aid in bringing Indiana into the growing list of states that are trying to save their streams from utter ruin.

Jersey City is trying to enforce a "No seat, no fare" ordinance in order to compel street railway companies to run sufficient cars to accommodate the traffic. This is one of the directions in which street railway companies in the United States are exceedingly neglectful of their obligations to the public. In the old horse car days, people became accustomed to hanging by a strap, and they have for years followed the same practice in electric cars without appreciating that they had any claim to be transported like human beings and not like cattle. At the present time most street railway managers are attempting to earn dividends on so much water that it is necessary to keep down car mileage and consequent expenses. In some cases, however, they have overstepped the mark and crowded cars to such a point as to lose a considerable part of the fares, delay the movement of cars through longer stops and discourage people from riding.

Of course, we appreciate the difficulties in handling the rush-hour traffic of morning and evening in the larger cities in such a way as to give every passenger a seat. One will not have to look far, however, to find street railway cars in which passengers are compelled to stand during other than rush hours; and where this occurs one may safely conclude that the management is either incompetent in arranging its car distribution and runs or else that it is deliberately crowding its cars to earn larger profits.

The various replies to our inquiry concerning the life of ties buried in concrete, published in this and the preceding issues, indicate that these ties are generally kept moist enough to effect permanent preservation of the wood. While the paving does shed much of the water to the gutter, there is always an open joint next the rail into which water will find its way; and the paving prevents evaporation of whatever water finds its way downward. It is likely, too, that the concrete in contact with the buried tie tends by capillary attraction to retain moisture and keep the wood permanently wet.

That continuous moisture is essential to the preservation of wooden ties laid under paving is indicated by the report of one correspondent in this issue who tells of ties laid in sandy soil which rotted in two or three years. It is well known, too, that the wooden stringers under the flat rail of the old-time horse car roads were subject to rapid decay, probably because they were so near the surface of the street that they were alternately wet and dry.

The question recurs whether there are special conditions such as in tropical climates or in arid regions, where wooden ties laid in concrete under street rails are liable to rapid decay.

The question whether water power shall be developed for the public benefit or for the enrichment of private owners appears likely to be fought to a finish in the State of New York. Heretofore the development of water power has been entirely a matter of private enterprise; and the development has been practically restricted to the low water flow of the rivers. Now, however, the State of New York has to undertake water storage on a large scale to conserve the water supply for the new 1,000-ton barge canal. The water-power thus created by the State's money ought to belong to the State, although there will undoubtedly be great pressure exerted to turn it over at a nominal rental to private concerns with political affiliations, as was done in the case of the old Erie Canal.

More important still is the public demand for the establishment of a scientific system of flood storage and river regulation. The State Water Supply Commission, in its report issued on Feb. 3, recommends the construction by the State of storage reservoirs on the headwaters of its principal streams. It has been estimated that the annual average loss by floods in New York State is $3,000,000. A complete system of flood impounding reservoirs would prevent all, or nearly all, this flood drainage and would yield the State besides a large annual revenue from the rental of the water power thus created.

The commission is convinced that it is practicable to build such reservoirs, although at an initial large cost. It would be necessary first to amend the law so that the State could control the flow of rivers and streams, and could regulate the price at which water for power purposes could be sold.

The necessity for placing such a system under State control and not under private control is apparent. A private concern would design its works for the largest profit merely, and would ignore the matter of flood control, both in the original construction and in subsequent operation. To illustrate: a power company might build a dam on a certain stream to develop power, and the size of the dam might be limited by the funds it had available, or by the nearby market for power. The construction of that dam might render impossible the construction of larger dams on that or other sites designed to control the flood waters and to give the largest possible reserve for the low water season.

The opportunities for great profit in water-power development with the aid of water storage are well known to private capitalists; and an association of owners of dam sites, power plants and lumbermen is trying to push through a constitutional amendment permitting the flooding of part of the State's forest preserve in the Adirondacks. The move is being generally opposed by defenders of the public interest; but the ground of opposition chosen is unfortunate. The proposed storage reservoirs are opposed because of injury to the State forest preserve, whereas it ought to be recognized that sooner or later these reservoirs must be created as a means of scientific river regulation; and that efforts should be concentrated to secure the benefits from these reservoirs and the water power which they will create for the public treasury and not the enrichment of private syndicates.

WATER-WORKS HAZARDS AT WASHINGTON AND BUFFALO.

The hazardous condition of some municipal water supplies is illustrated by recent reports on certain features of the water-works of Washington, D. C., and Buffalo, N. Y. Washington, according to the last annual report of A. Mackenzie, Brigadier General, Chief Engineer, U. S. A., is in sore need of a duplicate aqueduct. On this point Gen. Mackenzie says:

Attention is again invited to the danger of an interruption of the supply by an accident to the conduit. This structure has stood for nearly half a century and without interruption in its use other than to empty it periodically for cleaning. This fact is no guaranty that it will not be interrupted in the future.

It includes seven tunnels, aggregating 4,364 lin. ft., in seamy rock and unlined. They can not be lined until a new conduit is built. At every cleaning fragments of rock are found to have been dislodged from the roof. There is an appreciable risk of more or larger pieces falling in, sufficient to block the tunnel for a considerable time. There are 26 culverts, nearly all in made ground, the failure of any one of which would break the conduit. They are of massive construction, but equally strong ones have been washed out, and these may be.

The Dalecarlia reservoir is formed by an earthen dam across a valley. In this dam is the by-conduit. If this dam should break, the by-conduit would be destroyed and the supply of the District completely cut off.

The statement is justifiable that, notwithstanding its 50 years of uninterrupted use, the Washington Aqueduct is more vulnerable than the average of similar structures and that there is risk of an accident to it which would cut off the supply for a period long enough to cause a water famine, which would involve a cancellation of all fire insurance and a partial depopulation of the city, besides other and more calamitous consequences. This risk can be underwritten only by the construction of another conduit, or by increasing the supply in some other way.

With the idea of insurance paramount, a new conduit should not be built alongside the present one, but should follow a radically different course, to reduce to a minimum the chance of a single cause disabling both. For this reason all possible alternative routes and sources of supply should be examined and the preliminary surveys become more important and more extensive and will require more time.

An estimate of $10,000 for these surveys and investigations is submitted and its favorable consideration is urged. The cost of these surveys and any probable cost of a second conduit will be a very cheap insurance against the interruption of the water supply, which will remain a constant menace to the District until such insurance is effected.

Certainly such a warning should be given immediate heed by Congress and the appropriation for the necessary surveys made without delay. It would be a shame and disgrace to the whole country if an accident to the present aqueduct should cut off the water supply of the National Capital, thus subjecting government and private buildings to risk of fire, and residents and visitors to great inconveniences and to the possible ravages of disease.

The extremely hazardous condition of the water supply of Buffalo is brought out in a brief report by the Committee on Fire Prevention of the National Board of Fire Underwriters (135 William St., New York City). Although Buffalo is practically without water storage, and although the margin between pumpage capacity and water consumption and waste is small, yet the steam mains between the boilers and pumps are not duplicated, and as recently as Nov. 24 the steam main was broken and all the steam pumps were put out of commission for 15 hours. The accident was due to the wreck by a high wind of one of the brick walls of the partly completed new pumping station. Had it not been for a 25,000,000-gal. electrically driven centrifugal pump the city would have been absolutely dependent upon its very limited storage (1½ days' consumption) for the low service, with no storage at all for the high service. Even the electrically-driven pump was out of use for an hour. During the present winter the pumping engines "are housed in what is practically a frame building with tarred paper covering." Of course such inadequate housing of pumping machinery is only temporary. Moreover, we are pleased to be able to note that since the underwriters' report was published steps have been taken to increase the pumping capacity of the Buffalo water-works, and the commissioner of public works has been authorized to award a contract for a duplicate water intake tunnel, at a cost (contract price or bid) of $1,273,000. This tunnel, we understand, will supply a proposed new pumping station, thus duplicating the supply works, as distinguished from the distribution system. The need of some such comprehensive improvement has been recognized for some time. The delay in meeting the need appears to have been caused, at least in large measure, by a variety of local conditions, which need not be considered here. The city is to be congratulated on the prospect of a speedy lessening of its water-works and fire risks.

The enormous water consumption and *waste* at Buffalo (stated in the Underwriters' report as 350 gals. per capita per day) might well deter any city from providing duplicate supply works until the waste had been cut down. It is almost beyond belief that a city facing such risks as have prevailed at Buffalo for years should do so little—if anything of moment has been done—to determine the cause and amount of waste, as a preliminary to vigorous measures to suppress it. The Underwriters' committee, while suggesting meters for permanent waste reduction, urged house-to-house inspection this winter as affording some possible increase in the dangerously small margin between pump capacity and water consumption and waste. In a letter transmitting his approval of the proposed contract for a duplicate tunnel Mr. J. N. Adam, Mayor of Buffalo, wrote:

In carefully perusing the reports which have from time to time been submitted, I am more than ever impressed with the remarks that have so often been made with regard to the excessive consumption of water in Buffalo. There must be waste somewhere, and it must be corrected. The most rigid inspection must be made to ascertain how it occurs.

We wonder at the mildness of Mayor Adam's language.

There is still another risk at Buffalo that has received some consideration but deserves far more than has yet been given it. We refer to the fact that the water drawn from the Niagara River in such lavish quantities is polluted with sewage. Besides the known facts of pollution, this is indicated by the high typhoid records at Buffalo. For the five years ending with 1905 the city has had an average typhoid death rate of 42 per 100,000, and for the year 1904 the rate was 91. Filtration has been discussed from time to time, and we understand that the duplicate tunnel plans include connection to purification works of some character.

Washington, although not having so enormous a water consumption and waste as Buffalo, is yet notoriously wasteful, and many years were required to secure authorization for the construction of the filters believed to be necessary for the reduction of high typhoid rates. If the excellent filter plant recently built for Washington were to be followed by water waste reduction the need for a duplicate aqueduct, while still great, would be less urgent. Moreover, a reduction in water waste in the District of Columbia would be of benefit through reducing the rate of filtration.

The question naturally arises, are inadequate or impure water supplies, or both, so often accompanied by enormous consumption and waste? Philadelphia was for many years a notable example of this combination and its long-delayed filtration works might have been completed before this had the other city officials and the public listened to the pleadings for waste restriction made by Mr. John C. Trautwine, Jr., and other water bureau chiefs. Pittsburg, with filtration works now well on towards completion, is in much the same category as Philadelphia. Each of these Pennsylvania cities is at this moment suffering from an awful visitation of typhoid, which would seem, and doubtless would actually be, far worse if the inhabitants of those cities were not mentally dulled and to a considerable extent physically immune to the ravages of the disease, owing to some decades of experience and exposure. Allegheny, another victim of impure water and its resulting typhoid, is also a notorious water waster, and is doing nothing to improve its supply or reduce the waste.

In conclusion, it may be noted that the rapid growth of population and the increasingly high standards for the quality of water and for fire protection service makes it imperative that American cities should no longer rest content, as so many of them do, with supplying a lavish *quantity* of water, but should give at least equal attention to the *quality* of the water and the *general efficiency* of the service.

LETTERS TO THE EDITOR.

"What Column Formulas Shall Be Recommended for Practical Designing?"

Sir: Referring to your editorial comment on my letter published in your issue of Jan. 31, I would say that it is quite a surprise to me to learn that my use of the term factor of safety is "dangerously misleading." I used the words in what I supposed was their customary meaning, for, as expressed by Rankine, "a factor of safety is the ratio in which the load that is just sufficient to overcome instantly the strength of a piece of material is greater than the greatest safe ordinary working load." In more modern English it would be expressed "as the ratio of the ultimate load or load causing failure to the safe working load. If there is any uncertainty or doubt involved in my question as it stands it had better be re-written as follows:

Given a steel of 64,000 lbs. tensile strength, 40,000 lbs. elastic limit and a factor of safety (ratio of total load causing failure to safe working load) of 4, what is the best formula for designing a column made of this steel; why is it the best; and what is the maximum fiber stress when the column is loaded to one-fourth of its breaking load?

If the question "what is the best" is too hard a one to answer, then it may be modified to "what formula do you prefer, and why do you prefer it?"

I hope this clears the question of its alleged indefinite character.

Yours truly,

Wm. Kent.

Syracuse University, Syracuse, N. Y., Feb. 1, 1907.

More Concerning the Life of Ties Buried in Concrete.

Sir: During the past seven years in Seattle I have examined many ties imbedded in concrete except their tops, which were covered with 2 ins. of sand, over which was brick pavement. The ties when removed had been buried in the pavement from one to ten years.

The concrete mixture was invariably 1 to 4 to 7. This was mixed rather wet and tamped under and around the ties, and generally a rich mortar tamped out of the concrete was left on top of the ties when the concrete was smoothed off even with the tops. There was no care taken to spread the mortar over the ties nor was any attention paid to it at the time, but it was there as a matter of fact. As above stated the 2-in. sand cushion under the brick pavement was just above this.

In all cases the ties were in excellent condition when removed. They were of Washington fir and some were probably air and kiln-dried to a certain extent, but the majority were laid directly after they were received from the mills. On looking at the ties when removed, one would suppose that they had been treated before putting in on account of their dark color, but closer investigation and inquiry from engineers and others who had charge of the original work proved that they had received no treatment. Ties of the same wood laid in a sandy soil in a different part of the city, required renewing every two or three years.

The pavement over these ties was frequently flushed with fresh water. The filler used in the brick paving was sometimes sand and Portland cement mixed dry and swept over the newly laid brick, but it was generally nothing but dry sand. The space next to the rail at the end of the bricks was filled with a ⅝-in. board.

Water could therefore percolate through to the top of the ties, and they were probably always wet on top.

Yours truly,

Walter S. Wheeler.

Seattle, Wash., Jan. 26, 1907.

More on Failures of Reinforced-Concrete Structures.

Sir: In supplement to the comments on failures of reinforced-concrete structures which have already appeared in your columns, I offer the following remarks:

The average architect is content if he can draw a pretty picture; supervision of work (to be carried on under a fearful and wonderful specification at which the contractors laugh in their sleeves) is not taken much into account. The contractor often knows he is doing improper work under the specifications, but he naturally enough and with good show of reason says, "I have given up trying to teach an architect; they know it all. Besides, if I did point out anything wrong and proposed an alteration, I would not only get no thanks but would be left out of the list of competitors on his next contract."

Sometimes the superintendent of construction is a cheap incompetent individual whose interest it is to make friends with everyone. This variety is too frequently in evidence; as Nelson did on one memorable occasion, they know when to put the telescope to the blind eye.

A most objectionable feature of concrete work is the rough-and-tumble way of measuring the concrete components. A 1:3:6 concrete is not particularly rich, but when one measure is used for the cement, another for

the sand and a third for the stone the mixture may actually be from 1:4:7 downwards. Why is not the same measure used for all the materials?

The how often is it that the public is imposed upon by faulty tests? For instance, if a floor is to carry 200 lbs. load with a factor of safety of 4, it is accounted something marvelous if the floor carries 400 or 500 lbs. without serious damage!

What is the remedy for this unfortunate state of things, which, if allowed to go on, will give a powerful setback to concrete construction? If I may be allowed to make a suggestion or two, I would say:

1. That owners of concrete buildings in course of construction should take some sort of interest in the work themselves.

2. That any architect specifying concrete work should at least have some rudimentary knowledge of physics and the properties of the materials he employs.

3. That his supervisor should be a competent, independent man, not a workman in his Sunday clothes whose qualifications however good are usually confined to one or two branches of the business.

4. That under no circumstances should a contractor be allowed to design, execute, supervise and certify his own work.

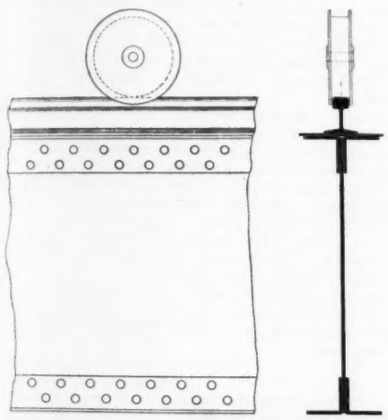
Yours truly,

H. J. Livingston.

166 Chamber of Commerce, Baltimore, Md., Jan. 1, 1907.

Distribution of Concentrated Loads Over Girder Flange Rivets.

Sir: The design of the flange-riveting in crane-girders and the like depends on the assumptions which are made as to the length over which the rail and top flange will distribute a concentrated load (see sketch below). Johnson's "Framed Structures" gives 42 ins. for this distance; other authorities give 30 ins. Both



recommendations are empirical, but appear to work all right, as the hundreds of successful girders prove. Will you or your readers give a mathematical solution of the problem?

Yours truly,

"Draftsman."

Ambridge, Pa., Jan. 23, 1907.

A Problem in Railroad Alinement.

Commencing at Station 1 (a section corner) a line is run N. 89° 39′ E., 1,705.0 ft. to intersect semi-tangent of curve shown, 166.1 ft. from P. C., the only intersection made with alinement. Thence on same course 902 ft. to Station 2. Thence on a back angle of 79° 20′ for 22.0 ft. to quarter section corner. A calculation is desired to define the point of intersection on curve of a line connecting the section corner and quarter section corner. This problem occurs in railroad work on infrequent occasions and the method of solving is usually slow. Can you suggest a speedy and accurate solution?

Yours truly, O. Dix Johns.

Ely, Nevada, Dec. 25, 1906.

[We know of no "speedy" solution of this problem, but the following is "accurate": First, solve the random triangle for the angle at Sta. 1. Then solve △ D A E for D A. Then, by analytic geometry, assume origin at center of curve (O) and figure intersection by equations of circle and straight line E A.

Solution:

In random △ (solving for ∨ D A E)

D A E = 0° 28.6′.

In △ D A E (solving for A D)

A D = 15.2 ft.

∴ F A = 15.2 + 166.1 = 181.3.

By analytic geometry:

Eq. circle = $x^2 + y^2 = R^2 = (716.8)^2$.....(1)

Eq. of a line = y = A x ± B (where A = tan of the angle line makes with X axis and B = intercept of line on Y axis).

∴ Eq. line E A = y = x tan α − O B.

α = 21° 26′ (4th quad.).
tan α = −0.393.

= x tan α − (F A + R tan α).
= −0.393 x − (181.3 + 716.8 × 0.393).
y = −0.393 x − 462.9..(2)

Subst. (2) in (1):

$x^2 + [0.154\ x^2 + 363.8\ x + 214{,}276] = 513{,}802.$

$1.154\ x^2 + 363.8\ x = 299{,}526.$

$x^2 + 315.3\ x = 259{,}554.$

$(x + 157.65)^2 = 284{,}408.$

$x = \pm 533.3 - 157.6.$

$x = -690.9.$

(or + 375.6, which is other intersection).

∴ y = −690.9 × −0.393 − 462.9.

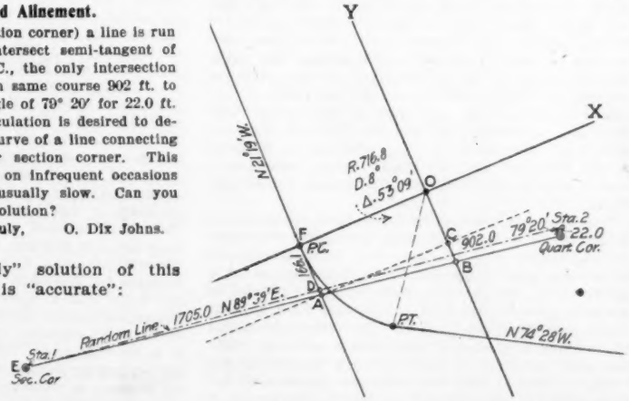
= −191.3.

From which, with O as center and coordinates shown, the point of intersection is (−690.9, −191.3.).—Ed.]

Common Faults in Reinforced Concrete Design.

Sir: Numerous discussions in the engineering papers regarding the design, failure and cause of failure of reinforced concrete structures, notably that on the Hotel Bixby in California, prompt the writer to offer the following remarks, growing out of several years' study in the design, and experience in the design and erection, of this class of structures. In the first place, the large majority of concrete buildings built in the Far West are the result of catalogue design and a jollying of the head of the building department. When the person employed to get out the architectural details undertakes to design a reinforced concrete building, he naturally learns of some patented device which is advertised extensively, communicates with the owners of patents or sellers of steel, and is furnished a catalogue giving all manner of formulas or tables, sketch designs, etc. Later, perhaps, a sketch plan is forwarded to the patented-device people, who furnish him a design, though they are entirely unacquainted with existing conditions—in many cases a totally irresponsible design, badly executed and showing a remarkable lack of knowledge of the principles of strength and mechanics of materials.

When the go-it-alone principle is followed with the assistance of an antiquated building code, a most remarkable collection of constructive details is produced, and if the work stands up it is through pure cussedness. Let me give some examples of what results under such conditions. Gas, steam and water pipes up to 6 ins. in diameter are carried up through columns and horizontally along the top and bottom flanges of beams (with total disregard of the danger which may arise from leaks, expansion and contraction, imperfect joints, etc.); electric conduits are carried up from the tension to the compression side of a slab, diagonally across the slab, with bends and curves in all manner of directions, cutting out one-half of the compression concrete and adding nothing to the tensile value; all this in 4¼-in. slabs on a 12-ft. span. Cinder (coal) concrete slabs



6 ins. thick and 18 ft. in span are reinforced with one layer of 3 × 10 or 4 × 12-in. mesh wire cloth when they must carry a total load of 150 lbs. per. sq. ft.

From the design standpoint, the existence of fixity or continuity in beams is mostly overlooked, or, when it is recognized, the required amounts of steel to take up the positive and negative moments, respectively, are directly misplaced; but most often the existence of the negative moment is overlooked. Consequently, in the design there is no continuity of metal over the supports and into adjacent members, proper bonds and anchorages are not provided, particularly at wall supports, etc., the positive-moment members are in numerous instances carried two-thirds of the way to the supports, and a pretence of taking up the negative moment is made by placing over the support a top reinforcing bar which is deficient in sectional area and length. Such a bar should be continuous through the member or else be carried from a point beyond the middle of the member to a corresponding point in the adjacent member, and by all means should be continuous over the support. In many instances no steel is provided for shear, and the concrete itself is insufficient to take up the combined compression and shearing stresses. Columns are not haunched or bracketed where necessary. Beams, where they cannot be made deep enough, are in many instances loaded up with compression steel. The necessity of stirrups and U-bars is overlooked, or where they are employed they are misplaced, are not of correct shape or are insufficient in number. A U-bar properly designed and placed should hold the top and bottom members securely in proper relative and absolute position at the supports, and then it no doubt will greatly assist in distributing the compression and shearing stresses and transferring them from one member to another.

The discussion by Captain Sewell in a recent issue of Engineering News seems to be entirely rational and has been used by the writer to a considerable extent, with the exception that a modification is made in dealing with built-in members at wall supports. Thus, taking an intermediate span under uniform load, the writer figures the maximum positive and negative moment each at $^1/_{12}wl^2$, inflection points approximately 0.22 of the span from the supports, and shear maximum at the support. With concentrated load the maximum positive and negative moments are each taken as $\frac{1}{8}Pl$, and the inflection points ¼ the span from the supports; main members amounting to two-thirds of the sectional area of the metal are brought around from top to bottom in a sweeping curve, cutting the inflection points at ¼ the distance from the support. In the span adjacent to the wall, where we have the condition of no continuity at wall and a moment greater than $^1/_{12}wl^2$ depending on the number of supports, but less than $\frac{1}{8}wl^2$, we can reasonably assume that the maximum positive moment is $^1/_{10}wl^2$. Proper anchorage at the wall supports seems to be of vital importance, and often the necessity of using inverted members for wall supports arises.

The proper placement and distribution of slab steel is next in importance. Slabs should be properly proportioned in ratio of width to breadth—a thing which is rarely done.

Yours very truly, B. J. Russell.

Seattle, Wash., Dec. 31, 1906.

Concerning the Compressive Unit-Stress in Reinforced Concrete.

Sir: I note that Mr. C. A. P. Turner in a letter to Engineering News (Jan. 17, 1907, p. 71), states in effect that 300 lbs. per sq. in. is ten times too low for rational working stress in concrete where suitably and properly designed reinforcement is used, and as an example cites where he had stressed seven-day-old concrete, placed at low temperature, from 1,800 to 2,000 lbs. per sq. in.

It is evident that Mr. Turner is not serious in recommending 3,000 lbs. per sq. in. as a rational working stress for concrete, but such a statement coming from an experienced concrete engineer, although in form of a hyperbole, makes it evident that he approves of much higher stresses than suggested by the writer, although just how much greater is not a matter of direct statement. The boldest designers of reinforced concrete in this country of which I have knowledge are satisfied with a maximum compressive unit of 800 lbs.

For work executed according to good common practice, under competent inspectors, I advocate 400 lbs. The 300 lbs. referred to in Engineering News by Mr. Turner was meant only to apply where good inspection was improbable. Exception may be taken to this on the basis that good inspection may always be had, but engineers who design concrete work, or pass upon concrete designs to be executed by others, know that first-class inspection will not be given to the work but that it will be constructed according to common practice in a given locality. For instance, plans for a concrete building are submitted to the city engineer (or building inspector) for approval on the basis of certain unit stresses. This city official as a rule does not test the cement, nor does he inspect the other materials which enter into the concrete work excepting superficially during occasional visits of this official or his subordinates. Yet the city engineer or building inspector stands morally responsible, in part at least, for failure. Now having

in mind that the great bulk of concrete work is done by inexperienced contractors, employing unskilled labor at prices which competition has made so low as to insure small profits, is 300 lbs. per sq. in. an unreasonably low compressive unit where first-class inspection will not be employed? The point that I am trying to bring out is that a great deal of concrete-steel work is not being built in first-class manner, and the designer of such work must give this fact due consideration. I have already stated in an article in Engineering News the reason for this: Competition has made the prices for this class of work too low, and the extraordinary growth of the concrete steel industry has made it almost impossible to get trained engineers, inspectors, contractors, foremen and mechanics for a large portion of the work.

The extraordinary tests which engineers are getting on reinforced concrete do not overthrow the conservative rules of common design. These high tests (tests made on actual floors, not in laboratories) are the result of (1) not testing a sufficiently large area, (2) piling the material employed in making the test loads so that more or less arch action exists in this piled material, so that figured bending moments do not actually occur, (3) making the tests on interior panels of a floor where there may be considerable arch action in the floor slab, which of course would reduce the bending moment and therefore the flexure of the floor, etc. Again, the beams are frequently figured as simple beams and as a matter of fact they are continuous; the slabs are figured as beams when they are more often plates. My idea is to figure the design correctly within the limits of rational theory and then allow a compressive unit of one-sixth the ultimate. As stated in spirit in my letter of January 17, if a contractor would agree to use a better grade of mechanics and material than is commonly in the market, and furnish a concrete which will give an ultimate of 3,000 lbs. per sq. in., and I had time to make occasional tests to make sure that I was getting such a concrete, I would not hesitate to use 500 lbs. per sq. in.

In regard to the arch action referred to in interior panels where unyielding abutments are afforded, this arch action is evidently the cause of the small deflections which are obtained from test loads and which apparently are contrary to the theory of beam action. However, when this arch action fails, as it must when the material at the top of the slab or beam crushes, the slab or beam will fail, and without warning. This arch action certainly permits of greater safe loads on the interior panels than would be the case if fixed abutments were not provided, but the amount to be allowed for the said arch action must be determined by tests made until failure is reached and not by means of the ordinary tests which indicate possible greater strength but not the degree.

The case cited by Mr. Turner is interesting and would be more so if the details of design and methods of loading were given. In this connection I wish to say that it is not uncommon to see parts of structures almost loaded to failure and yet carrying their loads with apparent safety. This case of Mr. Turner's reminds me of a case in which I lowered a 170-ft. steel span, complete, upon bridge seats set in soft mortar ⅝-in. thick. Very little mortar oozed out of the bed joints and there was no apparent settlement of the bridge seats. This does not prove that soft mortar in other circumstances is strong in compression.

I agree with Mr. Turner that no engineer is safe who suggests a uniform value for working stresses without taking into consideration the type of reinforcement, but an engineer can state a maximum, and an engineer who will not is not safe. Why should concrete stand alone as a material which should not be designed on the basis of a maximum permissible unit stress? Something must guide the engineer besides actual tests in the field after the work is complete.

The men who sell the so-called fancy bars have contributed and are still contributing not only to the demand for concrete structures but valuable theoretical and practical information, by which we of the round-bar class have profited in the past, even though we may have taken the test data of the vendor with an occasional grain of salt. I think there is a tendency of the profession to reject where possible patented systems of construction, and reject biased tests of patentees, yet a wholesale condemnation of all patented bars and all such data is not in accordance with liberal judgment. I know one patented-bar engineer who has done good missionary work, published good tables, developed sound theory, and has had exceptional success in the production of excellent concrete steel structures.

As to the round bar, I am an advocate of its general use because it is the cheapest bar, easiest to obtain and handle, the most adaptable, and not covered by patents; but in spite of this general statement I approve of mesh reinforcement for thin slabs, patented bars with attached web members for small beams, mechanical-bond bars for vertical reinforcement, and wherever in horizontal reinforcement bars of large sections are advantageous.

While it is my judgment that flat arches requiring steel reinforcement should not be built for economical reasons where arches of larger rise are practicable, yet when flat concrete arches are mandatory, I believe that the patented framed reinforcement is better than round rods.

The mere advocating of lower unit stresses in concrete than is the practice of many reinforced concrete steel engineers, does not mean that high stresses are the worst evils to be guarded against in order to save this excellent building material from unsavory reputation. The failures of reinforced concrete structures of which I have knowledge have been more largely due to poor details and poor workmanship. No maximum unit stress is safe in the hands of an incompetent designer or inexperienced contractor. Any maximum unit stress must be used on the basis of common sense or absurd results be the outcome.

For instance, where the steel base of a column rests upon a concrete footing having a top area three or more times the area of the steel column, a maximum allowable compressive unit-stress on the concrete may be as high as 800 or 900 lbs., as demonstrated by tests and in accordance with sound theory. It is evident that the concrete immediately below the foot of the column is restrained by the abutting concrete, and if the concrete immediately below the steel base should crush there would be no material settlement of the column, as the then crushed material would still be in confinement. Again, heavily hooped columns may be depended upon to carry a greater stress than is recommended in general by the writer.

Of course, in all reinforced concrete design, as in other work, we must consider static or moving loads, impact, vibration, probable frequency of maximum loads, result of failure of details, stiffness, class of materials obtainable, importance of structure, class of inspection, practice in a given community, etc., ad infinitum.

We use a maximum stress for steel, which is a much more homogeneous material than concrete; why not for concrete?

At present our knowledge of concrete is so incomplete, and the nature of the material itself so variable as not to permit of the fine gradation of the several classes of unit stresses considered in structural steel design.

In advocating a maximum compressive stress in concrete I do not think that this itself carries inference that common sense is not a requisite for the attainment of proper design, and I most earnestly suggest that the basis of all design must be the fundamental units.

Very respectfully,

W. J. Douglas,
Engineer of Bridges, District of Columbia.
Washington, D. C., Jan. 24, 1907.

"The Mechanical Examination and Analysis of Manufactured Rubber."

Sir: In the Nov. 22, 1906, issue of Engineering News appeared an article on "The Mechanical Examination and Analysis of Manufactured Rubber," reviewing two papers presented before the Brussels Congress of the International Association for Testing Materials. The method there given for a chemical analysis of india-rubber goods is certain to give incorrect values for the resin content because no account is taken of the solubility of free sulphur in acetone. In some cases this will give an error of more than one-third of the total resin content. For example, the inner tube of an automobile tire, examined in this laboratory, contained 1.54% of free sulphur. Two grams of the sample would, therefore, contain 0.0308 grams of free sulphur. Fifty cu. cm. of boiling acetone will dissolve about three times that amount of sulphur, namely 0.1152 grams, and consequently the percentage of resin given by the method of analysis in question will be too high by 1.54%.

India-rubber analyses are liable to quite wide variations due to imperfect mixing, and therefore imperfect sampling. Illustrative of this variation the following results are given and the effect of these variations in mixing upon an analysis for resin content will also be shown.

Two pieces of compounded, calendered, unvulcanized rubber, about 3 ft. square, were taken from the stock. Twelve samples were cut from each sheet, six parallel to the long axis of the calender rolls and six at right angles to it. The samples taken on a line parallel to the rolls were marked 1, 2, 3, etc., and those at right angles were marked A, B, C, etc. The percentage of total sulphur was determined in each sample under as nearly the same conditions as possible, using the method devised by Weber. The first compound consisted of fine Para rubber mixed with 5% of sulphur. The results of the determination were as follows:

Sample.	Per cent. sulphur.	Sample.	Per cent. sulphur.
1.....	4.61	A.....	4.35
2.....	4.77	B.....	4.94
3.....	4.18	C.....	4.91
4.....	5.16	D.....	4.21
5.....	4.64	E.....	4.38
6.....	4.35	F.....	5.28
Average.....	4.618	Average....	4.678

The second compound consisted of 14 lbs. fine Para, 40 lbs. Caucho Ball, 12 lbs. Whiting, 10 lbs. sublimed lead, 15¾ lbs. oxide of zinc, 1 lb. lime and 7¾ lbs. sulphur.

The sulphur estimations gave:

Sample.	Per cent. sulphur.	Sample.	Per cent. sulphur.
1.....	6.90	A.....	6.84
2.....	6.58	B.....	6.89
3.....	6.92	C.....	6.97
4.....	7.58	D.....	6.96
5.....	7.65	E.....	6.79
6.....	6.90	F.....	6.76
Average.....	7.103	Average....	6.824

To test further the variation due to imperfect mixing a piece of unvulcanized, calendered "boot upper" stock was sampled in this same manner and the total mineral content estimated by incineration. The results were:

Sample.	Per cent. mineral.	Sample.	Per cent. mineral.
1.....	51.43	A.....	51.49
2.....	50.70	B.....	50.24
3.....	50.78	C.....	51.27
4.....	49.76	D.....	50.70
5.....	50.75	E.....	53.90
6.....	49.55	F.....	53.10
Average.....	50.495	Average....	51.783

The variation here amounting to 3.66% in the latter series. Assuming that this compound consisted only of mineral matter and sulphur and rubber (although such is not the case it will affect this calculation a negligible amount) this variation of 3.66% in the mineral content would affect the total resin content about 0.38%, if a rubber containing originally 10% of resin was used. In the case of a higher grade compound, for example, using only fine Para rubber, the resin content would be affected only about 0.10%. Since the variations in the sulphur results were less than those in the total mineral in the "boot upper," the effect on the resin content would be correspondingly less. From these results it is very apparent that neglecting the "free sulphur" value will lead to an error several times greater than can be accounted for by imperfect mixing. But since "free sulphur" is soluble in acetone the determination of both resin and "free sulphur" can be carried out in one operation, and in fact in most cases this is done. The weight of the resin plus the weight of the "free sulphur" is obtained from this acetone extraction, and it but remains to oxidize the sulphur to sulphuric acid and precipitate it in the usual manner, to obtain the amount of sulphur present.

The method given in the article referred to above, for the estimation of "total sulphur" appears to give results much too low. An experimental compound containing 7.25% of sulphur and no mineral matter was prepared. this gave, using Weber's method, 6.95% and 7.14% of "total sulphur," while the method in question gave 5.59% and 5.45% of "total sulphur." The method was further tried on several stocks and in no other case was the percentage of "total sulphur" obtained so near to the theoretical value as in the above case.

While the method devised by Weber is probably the best one in general use, for general laboratory work, the results obtained by it are from 0.25% to 0.50% below the true value.

Yours very truly,

Lyman M. Bourne,
Chemist for the Eastern Reclaimed Rubber Co.
New York City, Jan. 18, 1907.

Construction of Dwelling House Walls of Terra Cotta Blocks.

Sir: The common reference to the architect as one, and to the "practical man" as quite another fellow may account for the distinguished diffidence of our craft and our fame for busying ourselves in other ways than speech. But having just come from a "Cement Products" convention, as well as from the contemplation of some of the wreckage of "armored" concrete that has been going on about us, may I be allowed a word before the drawing—for I can't shake off the impression that cement work continues to furnish the best field for quackery of any that is known to the building world, at least to that part of it located in our glorious "U. S. A."

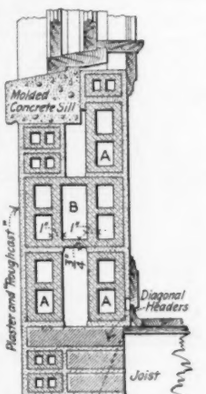
It is not everywhere so bad. The French undertook a decade or so ago to give us something of scientific value about the use of cement. But what they learned and taught has made little impression here. A few of our buildings of this material are well designed, many of them have slumped into their basements, while many more are still standing, no one seems to know why. As the medical quack does not hesitate to recommend his nostrum for dyspepsia, dandruff or in-growing nails, so the fellow with a "system" for reinforcing concrete will assure you that his particular bar (or whatever it is) will make 1 : 16 mixtures of most anything good, and that it is the only proper thing in column, beam or slab—no matter how or in what quantity used, or whether or no its presence as recommended makes it impossible to apply the concrete as it should be applied.

As to the economy of much of this work, no one seems to ask any questions. I was recently shown a large shop with a concrete roof. The large beams or girders weighed twice, and the whole construction some five times as much as the building code required to be provided for as "live load." Nor was the span excessive. Any one with the blood of a builder in his veins couldn't

help asking himself: How much more steel is required to hold up this concrete than goes into the steel skeleton of a good orthodox fireproof roof? How much greater is the floor cost of building and taking down the troughs, etc., in which all this was poured than the labor cost of a first-class roof of "mill construction?" and what is the value of the lumber destroyed in making and tearing down these supports for the concrete?

At the convention a large share of the clamor issued from the concrete building block and the machine for making it. If a veil might be drawn over 8 or 9% of these, or they might be used only in a region set apart for the blind, and if 90% might be prevented from being, the remainder might be tolerated. Later conventions are not so entirely given over to the bad as former. We have seen an imbecile at one of these exhibiting a block with something over a square foot of face decorated with an irregular arrangement of bulging hemispheres supposed to simulate a cobble-stone wall.

But while the average concrete building block of to-day is a nightmare in appearance, it is still unredeemed by any constructive or economic ideas of value to anyone, unless he live in some far-off place set apart for the unblessed. Let us suppose an architect set at work to devise a cheap wall of two or three stories for dwellings, say, of masonry, warm and strong, a wall that he would not be ashamed of by day. In our town, for instance, a three-story wall for dwellings may be 12 ins., if of brick; joist spans would not exceed 18 ft., and one half of two such floors with one-half of the roof and ceiling may be reckoned as 1,800 lbs. per running foot and satisfy the code, the weight of wall to be added. In our town also hollow partition and floor tiles are to be had of "porous" terra cotta, the clay well padded out with sawdust, the finished goods tough and strong and as slow to conduct heat as anything in masonry. Let us take two main forms of this, "A" a 14-in. partition tile, and "B" a floor tile with about 11-in. bed. The maker is mellow and he has so changed his molds as to give us thicker vertical members. Let us alternate A and B in course, using hollow bricks to level up about jambs as needed. We will use cement mortars, greased up with enough lime to make them work easy, and will have the work put up by men who set these tiles in fireproofing, men with the habit of filling end joints. This will give us generally four walls and three spaces and a very strong, stiff bond with less than 10% of material continuous through the wall—the wooden "balloon frame" has more.



Section of Wall of Porous Terra Cotta.

It remains to finish this wall on the outside with plaster of the best, that will please the eye and will seal from the weather.

The weight is hardly half of what a cement block wall of the same thickness must be and, when added to our 1,800 lbs., leaves us still well within the law.

Coming to cost, let us be very generous with these concrete people and assume that they can devise blocks for a 12-in. wall in which 40 sq. ft. face will consume but one cubic yard of material, and that they can get that cubic yard into decent blocks, delivered for $12.00, 30 cts. per sq. ft. at the building—that is the same as the wall shown by drawing costs *complete*, with outside plaster and "roughcast" (it has been done for considerably less on a single house).

As a heat-saver, no concrete block system that I have seen can approach the wall shown by the drawing, unless furred out for plaster on inside, while the former will absorb perhaps twice the heat of the latter, either summer or winter.

This is only one way; there are several others before we need to come to concrete blocks.

F. G. Corser.

907 N. Y. Life Bldg., Minneapolis, Minn., Jan 18, 1907.

Railway Location in the Malay Peninsula.

Sir: A short description of the conditions of railway location in the tropical jungle of the Malay Peninsula may interest your readers, especially now that the United States Government is initiating a system of railways in the Philippines under somewhat similar conditions as regards climate, jungle and labor.

The first requisite on starting survey work is to acquire the Malay language, a knowledge of which is quite indispensable. The writer found it a great advantage to have studied the language on board ship from Australia to such an extent as to be able to make himself understood on landing without having to use an interpreter. The language is very simple and rather euphonious and, if one only knows a little on arriving, proficiency is soon acquired.

A locating party consists of the officer in charge of location with one assistant living in the same camp and two other assistants generally camped behind, doing the final alinement, pegging and taking the levels; four Europeans only. Each white officer has a Malay "mandor" or foreman in charge of a dozen or more coolies, say 30 or 40 coolies in each camp, to do the survey work, camp-building and the carrying of luggage.

Now most of these Malays are quite new to the work and even the "mandors" have to be taught proper methods. Often, just as a coolie is getting to know something of the work, he finds that he has to go home, as his grandmother is dying, or his brother's wife is going to have a child, etc., so that constant changes are going on in the party. Two or three months is about the average term per man.

Apart from technical knowledge of his profession, one of the chief qualities which should be possessed by the surveyor is the ability to control and direct the native labor so that he makes himself liked as well as respected by the Malays, who are really only grown-up children; even the smartest of them. If a man cannot keep coolies, much of the advantage of his knowledge is counteracted.

The Malay is naturally a cheerful little fellow who forgets any hardships he may have had to bear as soon as he gets a good feed of rice and fish into him and has his cigarette. In the evening they spend their time singing, telling yarns and laughing at the slightest joke.

Our camp was made on a floor composed of saplings covered with bark and native mats, the floor being about four feet above ground. On the floor are fixed two tents, 10 by 12 ft., and above the tents is a roof of "attaps" or jungle thatch wide enough to cover a veranda in front, on which are fixed the drawing and dining tables. Behind the tents is the "dapur" or kitchen and sleeping place for three "boys" (servants); the cook, water boy and the waiting boy.

The mornings are generally fine, but the afternoons almost invariably wet, generally with heavy thunder showers, so that one very often arrives home wet through, but anyhow the jungle is always damp and there are often swamps to be waded, rendering it necessary to change all clothing immediately on returning to camp. Khaki clothes with canvas boots and puttees are always used in the field, and the Malay costume is used in camp, viz: a "sarong" (shirt) an undershirt and a "baju" (Malay coat). These are preferably of silk as being lighter and cooler and not susceptible to damp. After thus changing into dry clothes we have "tiffin" (or lunch) at two or three o'clock, having fasted since half-past six in the morning. The almost invariable food here is fowl, the common or garden variety—roast fowl, boiled fowl, curried fowl, cold fowl or fried fowl, so that one almost expects to find feathers growing out of his skin. Tinned meats are obtainable but are not relished in this climate.

Good tinned fruits and vegetables in water, or dried, can be obtained from Singapore. A good cook, Malay or Chinese, will serve up a tasty meal with soup, meats and light puddings, also a good bread and cheese. Edible game is rarely obtainable in the big jungle.

Regarding the work of location, in the Johore State there was practically no information to be had from maps, so that we had to construct our own maps as we went along. The mapping consisted mostly of the traversing of rivers and smaller streams the courses of which lay in the general direction desired.

With properly trained Malay mandors a fair amount of this work can be done by the Malays themselves, the mandor booking bearings and distances generally very carefully. In fact, I was lucky in having two Malay mandors who made fewer errors than the average white man in a similar position. It was quite surprising how careful and correct their work was, for I can hardly remember any cases of misreading of chain or compass bearing. Stations are numbered at every 100 ft. and at every angle, where also the forward bearing is written on the picket.

In localities where there appeared to be no watercourse leading in the proper direction, it was the writer's practice to run straight ahead, say for four or five miles, as a base for surveying the smaller watercourses, gaps, etc. Of course the straight line method was adopted only where it was known that there were no actual mountains. It must be remembered all the time that the country is completely covered with dense jungle, large trees and undergrowth of prickly creepers so that a mile an hour would be good going just to walk through, and a slower rate if one had to go through swamps. A mile or a mile and a quarter was generally a day's work for cutting out and chaining a compass traverse.

The work is all practically in the dark until the drainage system has been surveyed. Then a preliminary location traverse is run with alternatives in places and the usual methods are adopted to determine the best and most economical location. After a line of levels has been run over the preliminary, the officer in charge determines where contours are to be taken, whether to right or to left and approximately how far from the base.

The Malay mandor is given a list of what cross-sections to cut in the jungle and he takes his coolies out with compass and tape. The jungle is so thick that it will probably take them two days to cut as much as can be gone over by the topographer in one day.

The officer-in-charge or his assistant, after preparing sheets for topography, goes out with his sheets on a field board and takes the side slopes and puts the contours on the plan sheet. He takes a few coolies with him to hold the rods and to do extra clearing where required. The topographer has to be careful that nothing of importance is missed between the points where the cross-sections have been cut. The reader must constantly remember, while reading this letter, that the jungle prevents one from seeing more than 20 ft. away and that it is necessary to use a "parang" (jungle knife) to cut one's way through.

The rate of progress for complete location was about six miles per month where there were no extraordinary difficulties nor much alternative location to be tried.

The grades being limited to 1% and the curves to 3° made it necessary to follow river banks or watercourses. The generally rolling character of the country rendered ridge location impracticable.

After a sufficient area of country had been reconnoitered and a map of the streams had been made, the location was generally obvious. Where there was not much difference in length and curvature of alternatives it was sometimes necessary to compute yardage of earthwork and cost of culverts in order to determine the best location.

In this class of country it would be futile to attempt location without having first made a map of the drainage system of a fairly wide area. Without such a map any atempt at location would only lead to a great waste of time in surveying and to ultimate bad final location resulting in extra construction cost perhaps amounting to many times the whole cost of survey.

The amount of time taken in combating Nature's obstacles to surveying may, at times, cause the work to seem tedious, but there is no excuse for a man to achieve results of less merit in jungle country than in country bare of vegetation. One must not be afraid of doing a little too much preliminary work for, by utilizing the Malays, the cost does not amount to a great deal comparatively. A mandor's wages come to $10 or $15 (American) and coolie wages to $6 or $7 per man per month. They spend about $2 a month on food and, say, $2 on clothes and boots.

On the whole, jungle life is not unpleasant, the Malays being happy little fellows to work with, as they never quarrel and are invariably polite without cringing. By judicious, tactful management, they can be made to do a fair amount of work; indeed I have had a few individuals who were quite equal to the average white axeman. They are, as a rule, pleasant companions to travel with as they delight in keeping up a conversation about their own customs and about the habits of the animals and birds of the country. They have many quaint sayings or proverbs and fables in which animals largely figure, a little animal of the deer tribe taking the place which the fox does in our stories.

The fixing of the location was always interesting as the country was nowhere easy and construction was following close on location; so that one could see his work being actually carried out.

The physical exercise in exploring and struggling through the jungle tends to keep one in good health and appetite. The heat of the sun is not felt owing to the dense vegetation and at night one needs a blanket, for it gets quite cold towards three o'clock in the morning.

Transport is the most troublesome feature of the work when at any distance from civilization. Bullock carts with only two animals to each cart will take about half a ton, and travel two miles an hour, but they will only travel on the good metal roads. After leaving the main road everything must be carried by coolies. One Chinaman will carry 130 lbs. along a jungle track, but as a rule Chinamen will not go far from the villages; then one uses Malay coolies, who will only carry 30 or 40 lbs. and hate carrying, all the time. Fortunately we can often use river boats as streams are navigable almost up to their sources.

After two years of jungle work the writer feels in just as good health as ever; but one needs a spell occasionally. The Government is fairly liberal as to remuneration, allowances, traveling expenses and medical attention. Officers on survey and construction are engaged under agreement for eighteen months or three years, all traveling expenses being paid from port of embarcation and back.

Very truly,

D. M. Fraser,

Late of Seremban, Federated Malay States.

Melbourne, Australia, Dec. 11, 1906.

ERECTING AN EXTENSION TO THE STEEL SMOKESTACK OF A COPPER SMELTING PLANT.

The smelter plant of the Copper Queen Smelting Co., at Douglas, Ariz., has a self-supporting steel smokestack 25 ft. diameter and 200 ft. high, which was built by the Riter-Conley Mfg. Co., of Pittsburg, Pa., about four years ago, and was reported to be the largest steel plate stack in the country. Last year the company decided that it was necessary to increase the height, in order to obtain a stronger draft. How to perform the work, however, was a difficult problem, owing to the deadly character of the gases and smoke constantly pouring from the old stack. To shut down the plant even for a few hours would have entailed such heavy financial loss as to be out of the question. The plan finally adopted was devised by Mr. J. F. Jackson, M. Am. Soc. C. E., of Houghton, Mich., contracting engineer for the Wisconsin Bridge & Iron Co., of Milwaukee, Wis., which company undertook the work. The method proposed was approved by Mr. George B. Lee, the superintendent of the smelter. We are indebted to Mr. Jackson for drawings, photographs and information concerning this interesting piece of work.

The general plan was to build a strong timber trestle tower, constructed of mine timbers, extending to the top of the 200-ft. smokestack. This embraced the stack and extended laterally beyond it so as to carry a working platform on which the new 60-ft. extension could be erected at the side of the existing stack. Heavy timbers at the top of this tower or falsework supported a track of 15-in. I-beams extending outside the stack, and runners of 15-in. I-beams were attached to the base of the new section, the section of stack being fitted with outside braces to give a good support on the sliding frame. These triangular braces were attached by bolts to permit easy removal when the work was completed. Between the two lines of I-beams were nests of steel rollers.

The new section of the stack was erected on this framework, and had ten rings of 5-16-in. plate, each ring being 6 ft. high. At the base an angle-iron ring was fitted, to be riveted to the flange ring on the top of the old stack. The new section weighed about 40 tons. Its erection was attended with great difficulty, as work could only be prosecuted when the wind carried smoke and gases away from the workmen, and although the tower was placed on the side toward the prevailing winds there were days when the men could not work at all, and at other times when the winds were variable, a sudden shift of the wind would blow the sulphur fumes and smoke upon them so that they had to run for their lives. This is explained in a letter from the foreman in charge, Mr. Herman Eastland, printed below, which also describes the work of moving the extension into place, which was accomplished on Dec. 26, 1906.

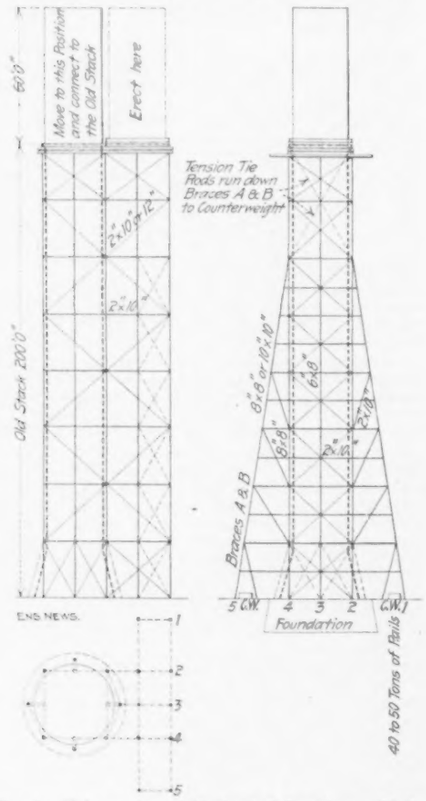


Fig. 1. Falsework and Method of Erecting a 60-ft. Extension for a 200-ft. Smokestack; Copper Queen Smelting Co., Douglas, Ariz.

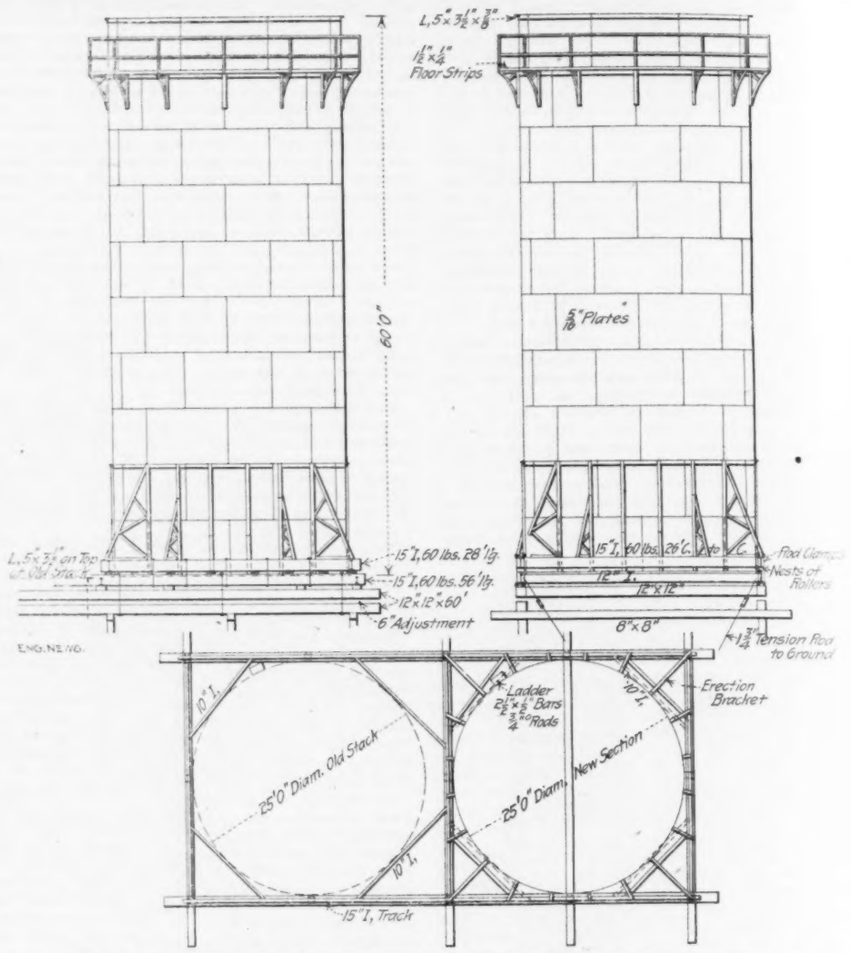


FIG. 2. 60-FT. EXTENSION FOR SMELTER STACK, WITH ARRANGEMENT FOR SLIDING IT INTO POSITION.

The actual time of moving the new stack onto the old one was about three hours. Everything went as well as was planned. There was no shut-down on the part of the smelter. I told them it was not necessary, as I figured that when I got the new stack half-way over, all the smoke would go up the new stack, and it did. It could have been moved in less time by using the wire rope and the engine which I figured on at first, but everybody was predicting disaster, even some of the men working for me. So I went the slow route, using a Barrett jack and a track jack and stopping frequently to let the vibration die out of the falsework. As far as I was concerned personally, I had plenty of faith in the falsework, as I have watched it very carefully on each addition of steel being added to the stack. When the new section had reached the height of 30 ft., the smoke kept getting worse. At that height the smoke spread out and kept circling the new stack. On several occasions I have had some of my men completely laid out by the smoke. I used a sliding line from the top of the falsework on the inside of the new stack to the bottom, and whenever the wind shifted suddenly, as it did quite frequently, we would all jump for the line and slide; those that were a little bit slow, of course, got the full benefit of the smoke, and were done up for the rest of the day. On some occasions we had about 60 ft. of smoke to go through before we could draw our breath.

Very high winds had to be provided for, and the falsework was made very substantial. Steel tie-rods were used in diagonal bracing, and on each side were tension tie-rods running down the batter posts or braces to counterweights composed of 40 to 50 tons of rails. Some additional weight was also added to the original foundation of the stack to take care of the increased overturning moment due to wind pressure on the 60-ft. extension. The temporary struts or braces at the base of the extension gave it ample stability to resist overturning during its erection as an independent structure, and it was designed to resist a wind pressure of 50 lbs. per sq. ft.

In the accompanying illustrations, Fig. 1 is a drawing showing the timber falsework and the positions of the smokestack and extension; Fig. 2 shows the extension, with the track, rollers and temporary braces at the base; Fig. 3 is a view showing the extension completed and ready to be moved into place, while Fig. 4 shows the moving almost completed and the stack increased in height to 260 ft.

ERRORS IN MUNICIPAL BUILDING REGULATIONS FOR REINFORCED CONCRETE CONSTRUCTION.*

By C. A. P. TURNER,† M. Am. Soc. C. E.

Let us refer briefly to some of these municipal building regulations which are objectionable or dangerous in that they encourage inferior work. Take for example, the building ordinances of the City of Chicago. These ordinances specify that reinforced concrete beams and girders shall be figured as simple beams, supported at the end, no allowance being made for continuous construction over the supports or columns. Now, in

*Extract from Presidential Address at the annual meeting of the Northwestern Cement Products Association.

†Consulting Engineer, 816 Phoenix Building, Minneapolis, Minn.

casting concrete, the material, if it is of a fairly rich mixture, shrinks in setting. For example, in a series of reinforced concrete arches of 10-ft. span, the writer has seen a section of concrete 3 ft. wide by 20 ins. deep crack right through at the crown of the arch, due to shrinkage stress in setting. The same action is going on between beams and columns in our buildings; hence, the construction, if it be safe, must take this condition into consideration in its design and provide for it in reinforcing, by thoroughly tying the various parts together. Reinforcement of the continuous beam type is best adapted to adequately provide for this condition,

Fig. 3. The 60-ft. Extension Ready to be Set on the Old Stack.

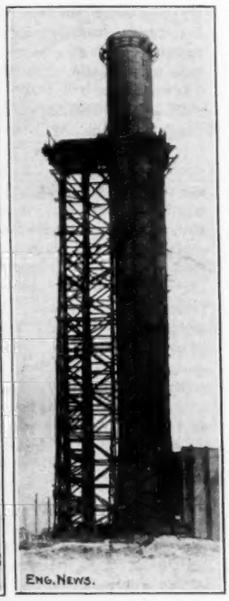


Fig. 4. The 60-ft. Extension Almost in Place.

whereas, this objectionable ordinance encourages the reversed type of construction.

Again, let us compare the formulas given in the Chicago building ordinances and in the ordinances of our own Twin Cities for slabs reinforced in one direction and in two directions. We have here a proposition that the building department considers the metal little, if any, more effective, when placed in two directions, than when it runs in one direction only. The absurdity of this proposition is evident if we consider the external moment in the two cases. The average external moment for the simple plate is $\frac{1}{8}$ w L^2, and the double average moment for the plate supported on four sides, each way, is $\frac{1}{12}$ w L^2; in other words, the moment is 50% more for the plate reinforced in one direction. In addition to this, we have the effect of the lateral distortion of the material which is treated in general equations of internal stress (see Lanza's "Applied Mechanics" or any general work on the subject) by a coefficient known as Poisson's ratio. The general effect of this can best be illustrated, to those not familiar with mechanics, as suggested by that eminent mathematician, Dr. H. T. Eddy, of our State University, by comparing the bending strength of a thin metal sheet, supported on two sides and the same sheet supported on four sides. They will find a most surprising difference in the force necessary to push the plate through between the supporting beams in the two cases. The same fact is illustrated in the case of slabs reinforced in two directions and supported on four sides.

Text book treatment of this subject in such works as "Reinforced Concrete" by Marsh, "Materials of Construction" by Johnson, "Concrete, Plain and Reinforced" by Taylor & Thompson, etc., is in error to a surprising extent; in fact, we can without injury load a slab reinforced in this manner to four or five times what its ultimate strength should be, computed on the basis of these incorrect formulas, and our building departments have not yet awakened to this fact by giving legitimate preference to the type of construction which insures the greatest safety.

This general failure in the building ordinances to take cognizance of the details involving the minimum risk in construction is also in evidence in the case of columns. It is a fact that there are many types of column reinforcement that are being put in and have been put in, in which the column, when reinforced with the metal, is weaker and more dangerous than it would be without any reinforcement at all, for the reason that it is either placed in such a form that it does not tie the concrete together, but, on the contrary, leaves it in a weak condition through shrinkage stresses, or through imperfect pouring of the concrete, in strong contrast with the types of reinforcement on the order of that adopted by Considere and others in keeping the reinforcement on the extreme outside of the column shaft and leaving the interior of the shaft unobstructed from the beam connection above to the floor below, enabling the concrete to be poured and consolidated without the interference of ties and obstructions through the shaft of the column.

A regulation too frequently included in building ordinances is the requirement, that under a test load, the deflection shall be a fixed proportion of the span, regardless of the ratio of the depth of the beam or slab to the span. Under such an ordinance, a beam might be readily tested to a deflection far greater than safe, conservative limits would allow, while a slab could not be strained to even a fair working stress, in order to pass muster under such a regulation. The absurdity of such an ordinance becomes evident when we consider that the deflection, with a given working stress, varies roughly as the cube of the depth; in other words, comparing the deflection of a beam 24 ins. deep and a slab of ordinary thickness, we should have approximately, for the same working stress in both cases, a deflection from 2% to 5% as great in the beam as would be permissible in the slab; and yet, ordinances are not wanting which demand that the limits of permissible deflection should be equal in both cases.

Another requirement which cannot be too severely condemned from the business standpoint is the unwarranted interference or prohibition of the conduct of concrete work at low temperatures. It is unquestionably a fact that when reasonable precautions are taken, the work can be conducted through the winter season and the resulting construction be fully equal to that which is put in under the somewhat unfavorable conditions frequently met in hot, dry weather; in fact, the speaker has no hesitation in stating that his experience indicates that the strongest and best concrete work is that which is executed at temperatures little above the freezing point; but if we are trying to make a finished and polished surface, a temperature of 60° F. is perhaps the more favorable.

In the Twin Cities reinforced concrete construction has come so rapidly to the front that there has not been, so far as the writer is aware, a single warehouse building constructed of structural steel in the past year; everything has been reinforced concrete or timber. In the notable example of the Lindeke-Warner Building, for which Butler Bros. of St. Paul, are the contractors, their bid on reinforced concrete construction was $10,000 less than their bid on timber mill construction. This building is 235 × 165 ft. and seven stories in height.

COMPETITION FOR A TAR-SPREADING MACHINE FOR USE IN LAYING ROAD DUST.

The Roads Improvement Association of England, acting in behalf of the Automobile Club and the Motor Union, has issued rules for a competition for a tar-spreading machine. Entries in the competition must be made on or before March 31, 1907. Ten judges of the competition have been appointed, including Mr. Rees Jeffreys, Honorable Secretary of the Roads Improvement Association; Mr. John A. Brodie, M. Inst. C. E., City Engineer of Liverpool, and Mr. H. E. Stilgoe, M. Inst. C. E., City Engineer of Birmingham. The rules are as follows:

(1) The merits of the competing systems will be judged on the following considerations:

A.—The efficiency of the application from the following points of view: (a) The penetration of the road; (b) the equality of distribution; (c) the quantity of tar the road is forced to absorb.

(N. B.—The road will in all cases be brushed with a machine brush to remove the accumulated surface dust, but the cost of such brushing will not be included in the cost of the application.)

B.—Cost of application per square yard: In estimating this cost the judges will take into consideration the probable cost of upkeep of the vehicle, and the depreciation that should be allowed for the various parts, or the vehicle as a whole. Fuel (the cost of which varies in different parts of the country) will be taken at London rates. For horse-drawn vehicles horse hire will be taken at London rates.

C.—Sound mechanical construction capable of resisting wear and tear.

D.—Simplicity of operation—i. e., the machine should be capable of being worked by the ordinary road laborers without skilled attendance.

E.—Ease and efficiency of operation from the following points of view: (a) Ease of refilling; (b) means to show the quantity of tar delivered to the road; (c) freedom from risk of clogging at the spreader; (d) facilities for running off unused tar and cleaning out; (e) mode of heating the tar or maintaining its heat; (f) mode of ensuring constant temperature at the spreader (either by separate chamber for heating fresh tar, or other suitable means); (g) rapidity of working.

F.—Suitability to varying road surfaces—e. g., the effective working of the machine on surfaces composed of different materials, up and down hill, or for treating footpaths, or for use under different climatic conditions.

G.—Immunity from fire risk.

(It will be obvious that the competition being a novel one, it is difficult to set out all the points to which attention may be given, but it may be suggested to competitors that, other things being equal, the advantage under head B will lie with the machine which can move most rapidly, which consumes least tar, which requires no skilled attendance, which can use the tar cold as well as hot, which requires refilling less frequently, and other like points. Under immunity from fire risks, for example, preference will be given to a machine heating the tar by steam coils.)

(2) AWARDS.—The machine which is adjudged to be the best will be awarded a first prize of 100 guineas and a gold medal, and the next best machine will be awarded a second prize of 50 guineas and a silver medal. The judges reserve the power to withhold awards if they consider that no machine entered is deserving of a prize.

(3) REGULATIONS.—The competition will be carried out by the Roads Improvement Association under these regulations by the judges, whose decision will be final.

(4) CONDITIONS.—The trial will be carried out, as far as possible, upon ordinary roads of varying characteristics. Vehicles may be either horse-drawn or mechanically-propelled, but, other things being equal, preference will be given to mechanically-propelled vehicles. The weight of the vehicle shall not exceed the weights specified in the Heavy Motor-Car Order.

(5) ENTRIES.—Every entry must be made upon the official entry form, to be obtained from the honorable secretary of the Roads Improvement Association. A separate entry form must be filled up for each machine, and the entry must be accompanied by a drawing of the machine entered, showing the general features of construction. This drawing will be treated as confidential for the judges' information only.

LAST DAY FOR ENTERING.—Entries cannot be received later than March 31, 1907. The competition will take place within three months following on dates to be announced later.

(6) TAR.—The tar will be supplied to the competitors by the association at cost price for practice and for the competition.

(7) FEES.—The entrance fee will be £10 10s., of which half will be returnable to those who actually compete.

We regret that we cannot give the exact address of Mr. Jeffreys, but doubtless communications intended for him would be forwarded by either Mr. Brodie or Mr. Stilgoe.

The following comments on the competition, and particularly on questions associated with tar as a dust layer or preventive are taken from the London "Contract Journal" for Jan. 16, 1907:

We are just a little sceptical that the results will be of the value expected, or that the proposed competition will bring forward any number of machines. The latter point is immaterial. If tar spraying is good, the machines will be forthcoming. It is necessary to go somewhat over old ground. The nuisance is dust, and tar spraying is a palliative. Among various questions three are prominent. Is it best and cheapest to make our roads in the first instance so that dust is a minimum? If they are made as they have been, is it cheaper to use water or tar? Lastly, if tar is used, will it cause another nuisance greater, equal to, or less than the one it is used to get rid of? The whole of the factors necessary to fully answer either of these questions cannot be obtained, and much has, therefore, to be assumed. Some things which bear on the subject are known. Thus a certain weight of material is periodically put upon a given length of road. In the ordinary course of things wear and tear takes place, and a ground-up weight of material is periodically removed—much is carried away during heavy rainfall, much is distributed as dust, and some is carted away. What difference is the use of tar going to make in the cost of carting? Wear and tear will continue. If no dust is to prevail, the wind will not assist the cart, nor to so great an extent will the rain; thus it becomes pretty certain that more carting will be the order of the day. Then what of the material carted? Will shoots for it be obtained so easily? Will it go into the first ravine, valley, or old pit? All these and many other questions have to be considered by those who are responsible for our roads. Housewives prefer clean mud to tarry mud carried by boots and shoes. Assuming, however, that all other things are settled, what is going to be the ultimate cost in comparison with water? We assume that the work is to be done effectively. The experimental work to prove the case will have to be ex-

tended till, among other things, we gain full information as to the time during which one spraying of a road is effective to prevent dust. It is seldom that water sprinkling is carried out often enough. If it were, we should get more mud and less dust. The experiments to be carried out under this competition will really do little, if anything, more than enable an approximate idea being obtained about the efficiencies of the machines tried. We take it that that is its one object, and there will be some pretty work for the judges. Take, for example, penetration—a very important factor. This will depend partly upon the condition of the road surface, and it is difficult to get two or more continuous lengths that do not differ largely; so that if great care is not taken to examine into the matter, considerable errors are likely to arise. Then the quantity of tar absorbed will prove a ticklish problem. Indeed, the palm should go to the least quantity with greatest penetration, for what is wanted is a coating just enough to cement grains of dust together, giving the mass sufficient weight that it cannot be moved by the forces acting upon it.

PROJECTED FURTHER DEVELOPMENT OF THE RIVER NILE FOR IRRIGATION.

Extensive improvements are being planned by the Egyptian Government for the River Nile. The present prosperity of Egypt and the extraordinary increase in the value of irrigated land consequent upon the completion of the Assuan dam and other kindred works, have stimulated the desire to have more of the same kind of benefit.

At present the entire flood discharge of the Nile, with its burden of fertilizing silt, passes through the sluices of the Assuan dam and produces the inundation of the delta which for thousands of years has been an annual blessing, while the falling waters are regulated and stored to be given out during the low-water season. This great benefit, valuable though it is, could be immensely increased if more water were available for the low-water season. Attention has therefore been directed to the vast equatorial swamp region, with its network of channels, obstructed by tropical vegetation, through which the Nile flows and out of which it emerges with but a third of its original volume, the other two-thirds being lost by evaporation and absorption.

A project is now being elaborated by Sir William Garstin, adviser to the Egyptian Ministry of Public Works, which can be carried out gradually as required and in the light of experience. Work on this project will shortly be commenced, and when completed will be an example of river regulation of a most colossal scale.

Preparations for initiating this improvement are already being made. Three powerful dredges of special type are to be built at once; their design has been entrusted to Mr. A. W. Robinson, the well-known American dredge designer. Mr. Robinson, who is now in Egypt, has started on a long exploration tour up the river in connection with the reclamation project.

NOTES FROM ENGINEERING SCHOOLS.

HARVARD UNIVERSITY. — Arrangements have been made for Harvard graduates interested in engineering, and residing in the vicinity of New York, to hold an informal dinner at the Broadway Central Hotel, in New York City, on Feb. 16, at 7 p. m. It is expected that Prof. Hollis and other members of the faculty will be present. Mr. Herbert M. Hale, 417 West 120th St., New York City, is in charge of the arrangements.

RENSSELAER POLYTECHNIC INSTITUTE. —Announcement was made at the annual meeting of the alumni of the institution, held at the St. Regis Hotel, New York City, Feb. 1, that Mrs. Russell Sage had given the institute, unconditionally, the sum of $1,000,000. It is understood that Mrs. Sage signified her intention of making a gift to the institute last November, but up to the time of the annual meeting no one except President Palmer C. Ricketts knew of the gift.

Referring to Mrs. Sage's gift, President Ricketts spoke in part as follows, regarding her interest in the institute:

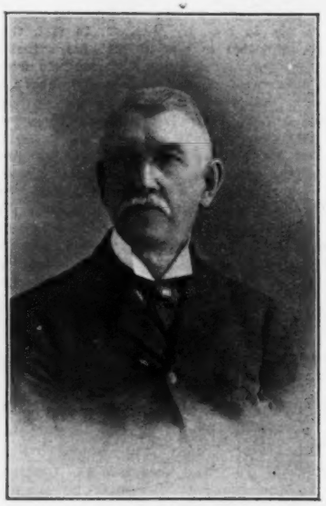
Mr. Sage was a Trustee of the institute for more than ten years. His nephew, Russell Sage, second, now deceased, was graduated from the institute in the class of 1859. Mr. Sage was twice elected a member of Congress from the Troy District, and he had many friends in Troy. Mrs. Sage lived in Troy for a considerable period of time, and is a graduate of the Emma Willard School. She also has warm personal friends in Troy. These are the reasons why Mrs. Sage has taken a great interest in the institute.

The money will doubtless be used to build, equip and maintain a school of mechanical and electrical engineering, of which the institute stands in great need. It is said that the gift will be divided as follows: For the erection of a building, $150,000; for mechanical equipment, $150,000; for a fund to repair and replace equipment, $300,000, and for salaries and other expenses, $400,000.

The institute was founded in 1824 by Stephen Van Rensselaer, and it is claimed that it was the first engineering school to be established in any English-speaking country.

HENRY CLARK SERGEANT.

Henry Clark Sergeant, whose name is familiar to engineers the world over for his inventions in percussion rock drills, died at his home in Westfield, N. J., Jan. 30, of paralysis, aged 72 years. Mr. Sergeant was born at Rochester, N. Y., but spent his early life in Ohio. He received only a common school education and at an early age began work in the machine shop. Here he soon saw the undeveloped possibilities of systematic manufacture by the aid of special machinery, and turned his attention to this subject.



Henry Clark Sergeant.

The first practical application of his theories was in the manufacture of wagon wheel spokes, hubs and felloes. For this work he designed special machines and at the age of 18 accepted a contract for manufacturing wheel parts in quantity, two years later becoming a member of a firm manufacturing wagon wheels. The routine of the factory was, however, distasteful to him, and he soon severed his connection with this company, and for the next six years followed various pursuits, chiefly commercial.

His first U. S. patent was issued to him when 19 years of age, the article being a boiler feed. In December, 1858, he patented a steam engine governor for marine engines, which prevented their racing when the screws were out of water. This governor was soon adopted by the U. S. Government and applied to the warships of that period. Then followed patents for gas pressure regulators, steam pumps, steam boilers, brick machines, water meters, etc.

Patents for three brick machines were issued to him in 1867, when he was a resident of Columbus, O. He shortly afterward moved to New York City, where he opened a machine shop of his own, building a wide variety of machines and developing many crude ideas. It was here that he really began his life work. In the early '70's Mr. Simon Ingersoll came to Mr. Sergeant with the drawings of the first Ingersoll rock drill, a then untried device, and he was immedia[tely] attracted by its possibilities, and the [Ingersoll] Drill Co. was formed to introduce the [Ingersoll] drill in rock excavating work. It is not [definitely] known how much he contributed to the [development] and success of the original drill, [but] at least one patent was issued to him [and] Mr. Ingersoll as joint inventors. Although [the] first drill was operated by steam, Mr. Sergeant [soon] saw the advantages to be derived by [using] it by compressed air, and also saw the [necessity] of using compressed air in mine and tunnel work. He therefore turned his attention to [improving] the design and details of the air compressor, as well as the drill. Later he formed a new partnership under the firm name of Sergeant & Cullingworth, to take care of the enlarged business, with shops at 22d St. and Second Ave.

Again tiring of manufacturing, Mr. Sergeant sold his interests to the Ingersoll Drill Co. and went to Colorado to put in operation some of his mining methods. Here he operated for a time a silver mine, but it did not turn out successfully. Meanwhile he had developed another complete rock drill with an entirely new valve motion, on which he secured two patents in 1884. He brought his new drill East in 1886 and formed the Sergeant Drill Co., with works at Bridgeport, Conn. Two years later his company consolidated with the Ingersoll company, and the Ingersoll-Sergeant Drill Co. was formed with Mr. Sergeant as its first president. The new company's shops were located at 9th Ave. and 27th St., New York City. Mr. Sergeant shortly retired as head of this combination and disposed of the bulk of his interest in the firm.

After a foreign tour, during which he spent much time in London and Paris, he became a director of the Ingersoll-Sergeant Drill Co., with the purpose of devoting all his time to invention in the interest of the company. He remained active in this capacity until two years ago, when failing health compelled him to give up the work. During these latter years Mr. Sergeant developed and improved many of the company's products and originated many new ideas in stone chanelling, coal undercutting and associated lines.

It is of interest to note that Mr. Sergeant was the inventor of the ticket cancelling box now used in all the elevated and subway stations of New York and other cities. This machine so mutilates the ticket that it is impossible to defraud the company by using it again.

In his early days Mr. Sergeant never stayed long in one position or locality, and up to 1893 he had lived in 26 different cities and towns. In that year he settled at Westfield, N. J., and since then had been a prominent citizen of that place. Although a successful inventor, as far as the utility of his inventions were concerned, he never realized any great fortune from his endeavors.

THE PANAMA CANAL CONTRACT is not yet awarded. The following statement concerning it was given out at the White House on Jan. 30:

Reports in the papers seem to indicate a belief that the canal contract has been conditionally awarded to Mr. Oliver. This is not so. No decision has been made even that the contract will be awarded to any of the bidders. Mr. Oliver's bid was so hopelessly defective that it could not be even considered, and time was given him to complete it in shape that will enable it to receive consideration.

If it is put into such shape, it will be considered together with the bid already made by the Gillespie-McArthur combination, which may itself be altered, and then whichever bid after the most careful examination seems most advantageous may be taken, or both bids rejected and the canal be constructed under the direct supervision of the Government. In such case the Government would, wherever it choose, use contractors simply as agents.

The real object in contracting the work is to have assembled a large number of the best specialists in each class of work, and the prime consideration will be the ability and fitness shown in a variety of directions by the men making the bid. The President and the commission would not even consider a bid of merely one or two men.

The work is already going well. Over half a million cubic yards were taken out of the Culebra cut in January, and the amount being taken out is steadily increasing.

The latter part of the above statement may possibly indicate that the Government is seriously considering the rejection of all the present bids and letting instead subcontracts for separate sections of the work. It is worth noting that if even the present average rate of half a million cubic yards per month were maintained, or 6,000,000 cu. yds. per year, the entire Culebra cut would be excavated in about eight years, which was substantially

the time for its completion by the Board of Consulting Engineers.

We announced last week the association of Mr. F. C. Stevens with Mr. W. J. Oliver as a financial backer, and on Feb. 5 the Panama Construction Co. was incorporated in New York with a capital of $5,000,000 and with the following incorporators: Messrs. John B. McDonald, the builder of the New York Subway; John Pierce, R. A. C. Smith and Geo. P. Harriman, of New York City; Wm. J. Oliver, of Knoxville, Tenn.; Chas. H. Ackert, R. A. Chester and J. J. Brennan, of Washington, D. C.; Geo. Pierce, of Frankfort, Ky.; P. J. Walsh, of Davenport, Iowa, and Robert Worsell, of Lynchburg, Va. The company was organized on Feb. 5 by the election of the above named incorporators as Directors, Mr. R. A. C. Smith as Chairman of the Board, Mr. John B. McDonald as President and Mr. Wm. J. Oliver as Vice-President and General Manager and Mr. R. A. Chester, of Washington, Vice-President of the Commercial National Bank, as Treasurer. Messrs. McDonald, Oliver, Pierce, Smith and Chester are the Executive Committee.

THE LAGUNA DAM on the Colorado River above Yuma, Ariz., according to a press dispatch of Jan. 25, is to be completed by the Government by day's work under an arrangement with the contractors, J. G. White & Co., who have turned over their plant to the Government engineers. The prosecution of this work has been attended with very great difficulties, which were indeed predicted by engineers familiar with the local conditions when the contract was let. The plans for the work were published in our issue of Feb. 9, 1905.

PROGRESS IN COMPLETING THE BREAK IN THE Colorado River is reported. It appears that since the completion of the trestle across the break on or about Jan. 26, a sufficient quantity of rock has been dumped to turn part of the flow of the river back toward the gulf. A telegraphic dispatch on Feb. 2 stated that the closure was progressing well and that a 4-ft. head had been obtained. Daily gage heights of the Salton Sea taken by the U. S. Reclamation Service near Salton, Cal., show that the level was at 71.35 ft. on Dec. 1 and 2, fell to 71.25 on Dec. 3, and remained there until Dec. 13, when it rose to 71.45. This period of stationary level, as we understand it, includes the period of closure of the river. From Dec. 12 to Jan. 20 the level rose from 71.25 to 74.35, or a total of 3.1 ft. This gives an average rise of 0.075-ft. per day. The datum of the Salton gage has a zero equal to 280 ft. below sea level, so that on Jan. 20 the surface of the Salton Sea was 205.65 ft. below sea level.

A REAR-END COLLISION on the Boston & Maine R. R., near West Deerfield, Mass., Jan. 29, killed five trainmen and injured several others. An express train had been stopped in a deep cut by the signal whistle in the engine cab; no cause for the stop signal has been discovered. A freight train was closely following the express, and was unable to stop in time to avoid a collision, although the rear brakeman displayed the danger signal. The accident occurred on a curve and downgrade. A combination baggage and smoking car and a day coach were the two rear cars of the express. They were the only cars smashed by the collision and were destroyed by fire afterwards. The engine of the freight was but slightly damaged. The dead men were riding in the express car at the time of the accident, and it is thought that they may possibly have given the stop signal.

A COAL TRAIN WRECK on the Chicago & Northwestern Ry., near Des Moines, Iowa, killed seven miners and injured a dozen other persons, Feb. 4. The accident was caused by a car in the middle of the train leaving the rails and ditching the cars behind it. The miners were riding in groups on different cars and were buried under the wreckage and coal, which took fire.

THE EXPLOSION of the boiler of a Pennsylvania R. R. locomotive near Fort Wayne, Ind., Jan. 30, killed the engine driver and fireman, injured a brakeman and wrecked 20 empty stock cars. The train was running at about 30 miles an hour when the accident occurred.

THE SCRANTON TYPHOID EPIDEMIC is considered to be over. The total number of cases reported from Dec. 1 to noon of Feb. 4, was 1,129, with 105 deaths. There were 831 cases in December, 294 in January, and 4 cases in February, up to Feb. 4. The deaths numbered 36 in December, 66 in January, and thus far 3 in February. On Feb. 2 the State Department of Health notified the Scranton Gas & Water Co. and also the people of Scranton that the company was at liberty to return "to the customary manner of operating the water-works," meaning thereby that the company might resume use of the Roaring Brook supply, cut out from the water-works system on account of pollution on or about Dec. 15. The state authorities declare, however, that this permission is given only because the use of the water from Roaring Brook is necessary to meet the daily wants of the city. The department states that although analyses of the water give negative results yet it believes the water unsafe for use unless it has been boiled. Mr. F. Herbert Snow, M. Am. Soc. C. E., Chief Engineer of the State Department of Health, has returned to Harrisburg, after having spent a number of weeks at Scranton.

TYPHOID FEVER IN PHILADELPHIA reached the enormous total of 1,692 cases for the five weeks ending Jan. 25. During the last week of the period 343 cases were reported.

PANAMA HEALTH CONDITIONS continue excellent. The report of the Chief Sanitary Officer for December, 1906, gives the following figures:

This month our force of employees reached the highest figure it has yet attained. In our total force of 8,200 whites, we have had eight deaths, giving us a rate for the year of eleven per thousand. This is exceptionally small. Of these whites, 6,000 are Americans, and among these Americans we had no deaths from disease. We also have 800 American women and children, the families of these employees, and among them there was no death from any cause. I call particular attention to the drop in the number of deaths in the town of Colon. In November we had 77 deaths; in December, 48. The sick rate among the employees has been about what it was last month—30 per thousand; that is, out of every thousand employees we had thirty constantly sick. This is a small and satisfactory rate. During the month we had no quarantinable disease of any kind.

A MINE EXPLOSION in shaft No. 25 of the Davis Coal & Coke Co., at Thomas, West Va., Feb. 4, killed 37 miners, all foreigners, and injured several others, according to press reports. The cause of the accident is not known and rescue work is proceeding slowly on account of the drift, which is a mile in length, being filled with gas.

THE EXPLOSION OF AN ICE MACHINE in the power-house of Armour & Co., Chicago, Ill., Jan. 28, killed three men and injured 16 others. The head of a cylinder of an ice machine blew off, filling the room with ammonia fumes, which quickly overcame the workmen.

THE BUFFALO BREAKWATER was considerably damaged in the storm of Jan. 20. The superstructure on 1,910 ft. of the old breakwater, built 1884 to 1891 was practically destroyed to water level by the storm, which lasted for nearly 24 hours, a southwest wind attaining a maximum velocity of 84 miles per hour. The superstructure destroyed was of timber, 36 ft. wide, and built on a timber-crib foundation. It was decayed and had been repaired several times. A large number of deck planks and wall timbers on other parts of the breakwater having a timber superstructure were broken or displaced. The portion of the breakwater built entirely of stone during the years from 1897 to 1903 was not damaged in any way by the storm.

THE PHILADELPHIA FILTRATION CONTRACT suit in equity, under which the city sought to annul 16 contracts awarded by it to D. J. McNichol, has resulted in a decision to the effect that five of the contracts are void, six legal and five to be left to a decision in another suit previously brought by the contractor. The basis for declaring five of the contracts void was that they were entered into while James P. McNichol (now State Senator) was a member of the City Council. The same McNichol was a member of the City Council at the time the next six contracts were awarded, but resigned just before they were executed, and therefore the Court holds that these six contracts were legal. The ten contracts already mentioned have been completed; the remaining six contracts of the 16 were declared cancelled by the city before their completion, and these the Court in the present suit declined to rule upon. The records show that there was a net profit of about $117,000 on the five contracts just declared void, and this sum, at least, it is expected that the city will recover. The gross profits were considerably above the sum named, but there was a loss on some of the contracts, and it remains to be decided whether or not this loss shall be deducted from the gross profit. The decision states that D. J. McNichol was only a figure-head, the financially responsible parties in interest being James P. McNichol, Israel Durham, State Superintendent of Insurance and "political boss" of Philadelphia, and John M. Mack, a Philadelphia contractor. In an agreement between these three men and D. J. McNichol the name of Mrs. J. P. McNichol was substituted prior to the date of her husband's resignation from the City Council; but the Judge declares the use of her name was merely a cloak. Various points raised, involving the integrity and good faith of former directors of public works Haddock and Costello, were all held by the decision as unproved. It is reported that neither side to the suit is satisfied, and that an appeal will be taken.

THE NEW YORK STATE WATER SUPPLY COMMISSION has made a number of interesting recommendations in its second annual report, just filed at Albany. These include suggestions that the Commission should be given authority to supervise the execution of plans for public water supplies as well as approve them; also that there should be State supervision of the construction of dams and reservoirs and of the maintenance of old dams. In addition, the Commission recommends that storage reservoirs be built by the State to prevent floods, and that the State be allowed to sell power thus created.

FATAL ACCIDENTS to the number of 1,056 occurred in the mines and quarries of Great Britain and Ireland in 1906, according to statistics taken from the Home Office report and printed in "The Iron and Coal Trades Review." The accidents were divided as follows: Explosions of fire-damp or coal dust, 16; falls of side or roof, 531; shaft accidents, 65; miscellaneous underground accidents, 316; miscellaneous surface accidents, 128. The total number of deaths resulting from these 1,056 accidents was 1,133, divided as follows: Explosions of fire-damp or coal dust, 54; falls of side or roof, 547; shaft accidents, 68; miscellaneous underground accidents, 329; miscellaneous surface accidents, 135.

NET EARNINGS of the United States Steel Corporation for the year 1906 amounted to $156,619,111, an increase over the previous high record made in 1902 of $23,310,348. These earnings are some $37,000,000 greater than the earnings of 1905, and are more than double those of 1904. Furthermore, the earnings of the last quarter of 1906 exceed those of any other quarter in the history of the corporation. The unfilled orders on hand at the end of 1906 also exceeded all previous records, and amounted to 8,489,718 tons.

GOVERNMENT OWNERSHIP OF TELEPHONES is proposed by the province of Alberta, Canada. Manitoba recently voted for government ownership of telephones, as has already been noted in these columns.

SEWAGE CONTAINING WASTE LUBRICATING OIL has caused trouble at the Lyndhurst sewage disposal works of the New Forest Rural District Council, England. Acting on the advice of Mr. W. B. G. Bennett, M. Inst. C. E. (Midland Bank Chambers, Southampton, England), an additional percolating filter bed for the special treatment of this sewage was prepared. The filtering material used was ligno-carbon, supplied by the Ligno-Carbon Co., of Heathfield, Newton Abbot, South Devon. The sewage is applied to the bed by Ames-Crosta spray jets. The London "Surveyor" states in its issue of Jan. 18, 1907, that the bed "has been in operation with very successful results for nearly two months."

STREAM POLLUTION BY STRAWBOARD WASTE has been investigated by Mr. Earle Bernard Phelps for the U. S. Geological Survey, in cooperation with the Sanitary Research Laboratory and Sewage Experiment Station of the Massachusetts Institute of Technology. The results of the investigation have been published as Water Supply and Irrigation Paper No. 189 (U. S. Geological Survey, Washington, D. C.). Mr. Phelps' investigation was in some respects a continuation of an earlier study by Prof. R. L. Sackett, of Earlham College, Richmond, Ind. (published as Water Supply and Irrigation Paper No. 113). Mr. Phelps first experimented with a number of barrels of strawboard waste shipped to him at the laboratory mentioned above. Subsequently he continued his studies at one of the mills of the United Box-board & Paper Co., at Urbana, Ohio. In these experiments, use was made of a mechanical filter loaned by the New York Continental Jewell Filtration Co., of New York. Both the laboratory and field experiments are described in detail in the paper mentioned above. Mr. Phelps summarizes his conclusions as follows:

The present method employed for the treatment of strawboard waste liquor, that of sedimentation in large fields, is unsatisfactory and expensive and proceeds on a wrong principle.

The filtration of the liquor through sand, so-called mechanical filtration, but without coagulants, after a short period of sedimentation will remove 93% of the suspended organic solids and 98% of the total suspended matter determined as turbidity.

Actual experiments have shown that the resulting effluent can be discharged into an equal volume of reasonably pure water without creating a nuisance. In particular, there will be no sedimentation of organic matter. If its discharge into a seriously polluted stream should bring about precipitation of sewage matter and consequent nuisance, the blame should in all equity be fixed on those contributing the sewage.

The sludge resulting from the sedimentation tanks, after pressing or spontaneous drying, is innocuous and makes good soil. It has some value as a fertilizer and is particularly valuable to mix with the clay soils of the Middle West to render them more porous. Other uses for this material are suggested, but they require further study.

The cost of the entire process is sufficiently low to admit of its adoption wherever stream pollution is serious.

THE UNDERGROUND TELEPHONE WIRES of the American Telephone Co. (Bell) at the close of 1906 measured 3,285,742 miles, or 54% of the total mileage. The company on the same date had a total of 11,373 miles of submarine wires.

A NEW OCEAN LINER OF IMMENSE SIZE will soon be built for the Hamburg-American Steamship Co. in the yards of Harland & Wolff at Belfast, Ireland. The new vessel is to be called the "Europa" and is expected to be launched in 1908. She will have luxurious passenger accommodations, including Turkish baths, elevators, a tennis court on the promenade deck, and a swimming tank, 75 × 25 ft. There will be accommodations for 550 first-class passengers, 350 second-class, 1,000 third-class, and 2,300 steerage. With the 500 men required for the crew, the vessel will carry 4,700 persons, the largest of any of the transatlantic liners. The new vessel will have a speed of 19 knots per hr., a displacement of 42,000 tons, a length of 750 ft., and a beam of 80 ft.

A PROJECTED LONGITUDINAL RAILWAY in Chile has been approved by the Chilean Congress, 5% interest being guaranteed by the government on the bonds for the estimated cost of $37,500,000. Congress has given the President authority to enter into contract for the whole work or parts of it, subject to the approval of the Senate. This railway will run from the frontier of Peru to the Straits of Magellan, a distance of about 2,600 miles, and will have spur lines to coast ports and into mining and agricultural districts.

THE VOLUME OF COMMERCE ON THE GREAT Lakes is well shown by the recent report of the engineer officer at the ports of Duluth, Minn., and Superior, Wis. In the calendar year 1906 at these twin ports there was received and shipped a total of 29,171,221 tons of freight, valued at $251,899,844, an increase in freight tonnage of 924% over 1890 and of 28.6% over 1905. On account of a different system of keeping accounts at the custom houses of lake and ocean ports, it is hard to compare the various ports of this country, but considering the fact that the lake commerce is open but eight months of the year, the mean monthly freight movement at Duluth-Superior Harbor during the season of navigation is second only to that of New York.

THE PHYSICAL VALUATION OF THE MILWAUKEE Street Railway Properties is being made by Prof. W. D. Pence, M. Am. Soc. C. E., Engineer of the Wisconsin State Board of Assessment and the Railroad Commission of Wisconsin, on behalf of the boards named. Associated with Prof. Pence are: Mr. Bion J. Arnold, M. Inst. E. E., President of the Arnold Co., Chicago, Consulting Engineer; Mr. C. M. Larson, Chief Roadway Inspector; Prof. John G. D. Mack, M. Am. Soc. M. E., Chief Mechanical Inspector, and Mr. George Weston, Chief Electrical Inspector.

PERSONALS.

Mr. T. H. Bacon, Assistant Chief Engineer of the Chicago Great Western Ry., has resigned.

Mr. A. D. Benton has been elected Manager of the Paymaster Consolidated Mines Co., Tucson, Ariz.

Mr. Joseph Luxon has been appointed Superintendent of the Ivanpah Mammoth Gold & Copper Mining Co., San Diego, Cal.

Mr. Edmund S. Kirby has been elected Manager of the Federal Lead Co., Flat River, Mo., to succeed Mr. Thomas F. E. Fitzgerald, resigned.

Mr. W. W. Keefer has resigned as General Superintendent of the Pittsburg Coal Co. and the Monongahela Consolidated Coal & Coke Co.

Messrs. Paul Paradis and F. W. Thorold, of Calgary, Alberta, have been appointed Consulting Engineers to the Union of Municipalities of Alberta.

Mr. E. M. Kenley, M. Am. Soc. C. E., has been appointed Chief Engineer of the Yakima Inter-Valley Traction Co., of North Yakima, Wash.

Mr. O. Cornelisen has been appointed Superintendent of Transportation of the Chicago Great Western Ry., in charge of movement and disposition of cars.

Mr. R. L. Edwards has resigned as Manager of the City Rocks Mining Co., Alta, Utah, to become Manager of the Golden Eagle Mining Co., Winnemucca, Nev.

Mr. John E. Zimmermann, formerly Secretary of the American Pulley Co., of Philadelphia, Pa., has become a partner in the firm of Dodge & Day, Engineers, Philadelphia, Pa.

Mr. William W. Rousseau, Jr., has been appointed Engineer and Superintendent of Construction of the Water-Works Department of Troy, N. Y., at a salary of $1,500 per year.

Mr. H. J. Armstrong, of the Engineering Department of the Atchison, Topeka & Santa Fe Ry., has been appointed Instructor in Civil Engineering at The Armour Institute of Technology, Chicago, Ill.

Mr. James Russell, Superintendent of the Omaha Division of the Missouri Pacific Ry., has resigned to become Superintendent of the Chicago, Burlington & Quincy R. R. lines in Illinois. His headquarters are at Beardstown, Ill.

Mr. Benjamin L. Williams, Jr., Superintendent of the West Orange Water Co., has resigned to accept a position with the Edison Phonograph Works at West Orange, N. J. He will have charge of the water, steam and gas piping systems of that company.

Mr. A. E. Erwin has been appointed Superintendent of Bridge Construction on the Beaumont, Sour Lake & Western R. R. He will have charge of the bridges being erected over the Trinity and San Jacinto Rivers by the Kenefick, Hammond & Quigley Construction Co.

Mr. D. W. McMorris, M. Am. Soc. C. E., Assistant Engineer in local charge of the fortifications being constructed by the War Department at Corregidor Island, P. I., has resigned and returned to the United States. He has accepted the position of Assistant City Engineer of Seattle, Wash.

Mr. Frederick P. Kafka, Manager of the New York office of the Unit Concrete Steel Frame Co., has resigned and accepted a similar position with The General Fireproofing Co., of Youngstown, Ohio. He will have full charge of the reinforced concrete department. His address is 156 Fifth Ave.

Mr. Frederick P. Stearns, Chief Engineer of the Metropolitan Water and Sewage Board of Boston, Mass., has resigned and become Consulting Engineer of the Board. Mr. Dexter Brackett, Engineer of the Distribution and Sudbury Departments of the Board, has been appointed Chief Engineer, to succeed Mr. Stearns.

Mr. J. C. L. Fish, Assoc. M. Am. Soc. C. E., Resident Engineer of the Eastern Division of the Franklin & Clearfield R. R., has been promoted to be Division Engineer of the Eastern Division, with headquarters at Corsica, Pa. He is succeeded as Resident Engineer by Mr. H. M. Chapin, with headquarters at Limestone, Pa.

Mr. S. S. Stiffey, Superintendent of Motive Power of the Hocking Valley Ry., has been appointed General Superintendent of Motive Power of the so-called Morgan lines in Ohio. He will have jurisdiction over the Hocking Valley Ry., the Toledo & Ohio Central Ry., the Kanawha & Michigan Ry. and the Zanesville & Western Ry.

Mr. C. T. Alden has been placed in charge of the Electrical Department of W. S. Barstow & Co., New York City. Mr. Allen was successively connected with the American Locomotive Co., the General Electric Co., and the Bath Iron Works before taking the above position. Mr. M. O. Jenkins is Assistant Electrical Engineer.

Mr. L. H. Wheaton, formerly Chief Engineer and General Superintendent of the Coast Ry., at Yarmouth, N. S., and for the past two years Chief Engineer for MacKenzie, Mann & Co., in charge of the construction of the Halifax & Southwestern Ry., which has lately been completed, has been appointed Engineer of Maintenance of Way for the last named road. His headquarters are at Bridgewater, N. S.

Mr. John Kennedy, M. Am. Soc. C. E., Chief Engineer of the Harbor Commission of the Canadian Government, has resigned after 32 years of service, on account of failing eyesight, and has been made Consulting Engineer to the Commission. Mr. Kennedy is a Past President of the Canadian Society of Civil Engineers. Mr. F. W. Cowie, M. Can. Soc. C. E., Superintending Engineer of the St. Lawrence Ship Channel, has been appointed to succeed Mr. Kennedy as Chief Engineer. He will for the present attend to the duties of both positions.

Obituary.

Isaac Harris, a member of the firm of Harris & Maguire, contractors of Brooklyn, N. Y., died in that city Jan. 30, aged 69 years.

William L. Simpson, M. Am. Soc. M. E., a well-known mechanical engineer of Philadelphia, Pa., died at his home in that city, Feb. 1, aged 60 years. He was a native of Philadelphia and the founder of the Keystone Engine and Machine Works.

Charles E. Walker, a civil and mining engineer well known on the Pacific Coast, died Feb. 2, at Brooklyn, N. Y., aged 63 years. At the time of the building of the Chicago & Northwestern Ry. he was employed on the division extending from the Mississippi to the Missouri River.

Solomon Turck, a pioneer powder manufacturer and a former President of the Laflin & Rand Powder Co., of New York City, died at his home in that city Jan. 30, aged 79 years. He was born at Kingston, N. Y., and entered the powder business in 1853. He became President of the Laflin & Rand Company in 1872.

George J. Grammer, Vice-President of the New York Central & Hudson River R. R., died at Chicago, Feb. 4 death being due to an operation made necessary by liver trouble. He was born at Zanesville, Ohio, Nov. 11, 1845, and entered the railway service in 1881. In May, 1883, he was appointed General Freight and Passenger Agent of the Evansville & Terre Haute R. R., later becoming Traffic Manager of the same road. From May, 1886, to December, 1892, he was General Traffic Manager of the Peoria, Decatur & Evansville R. R. On May 1, 1894, he became General Manager of the Chesapeake, Ohio & Southwestern R. R. and General Freight Agent of the Michigan Southern & Lake Shore Ry. on March 1, 1896. He was made Vice-President of the New York Central lines last December.

ENGINEERING SOCIETIES.

COMING MEETINGS.

THE NATIONAL BRICK MANUFACTURERS' A[illegible]TION.
Feb. 4-9. National Convention at St. Louis, M[illegible]. Theo. A. Randall, Indianapolis, Ind.

CONNECTICUT SOCIETY OF CIVIL ENGINE[illegible]
Feb. 12-13. Annual meeting at Hartford, Co[illegible]. J. Frederick Jackson, New Haven, Conn.

NEW ENGLAND GAS ASSOCIATION.
Feb. 21. Annual Meeting at Boston, Mass. [illegible] N. W. Gifford, East Boston, Mass.

ASSOCIATION OF ONTARIO LAND SURVE[illegible]
Feb. 26. Annual Meeting at Toronto. Secy [illegible]alay Gamble, 405 Temple Bldg., Toronto, Ont.

AMERICAN RAILWAY ENGINEERING AND [illegible]NTE-NANCE OF WAY ASSOCIATION.
March 19-21. Annual Meeting at Chicago, Ill. [illegible]. L. C. Fritch, 1562 Monadnock Block, Chica[illegible] Ill.

IOWA ELECTRICAL ASSOCIATION.
April 18-19. Annual Meeting at Clinton, Iowa. [illegible]. L. B. Spinney, Iowa State College, Ames, Iowa.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—An illustrated lecture on "Gasoline [illegible] Its Uses," by Prof. Charles M. Allen, Professor of Experimental Engineering at Worcester Polytechnic Institute, will be given Feb. 12, in the auditorium of the Engineering Societies, 29 West 39th St., New York City. All officers, engineers and representatives of companies engaged in the manufacture of automobiles are invited to be present.

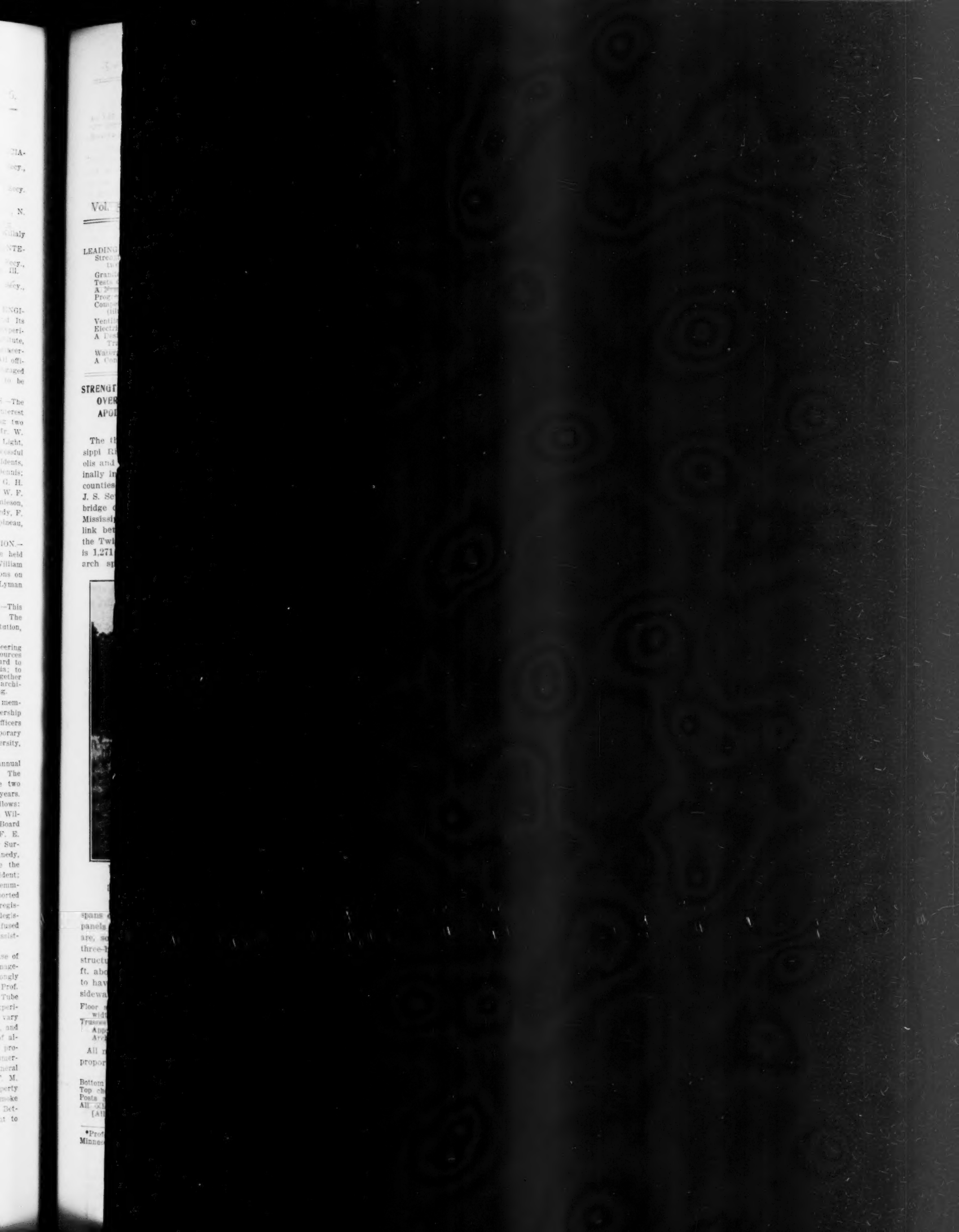
CANADIAN SOCIETY OF CIVIL ENGINEERS.—The annual meeting was held at Montreal, Jan. 29. Interest centered in the election of President, there being two candidates, Prof. J. Galbraith, of Toronto, and Mr. W. McLea Walbank, Chief Engineer of the Montreal Light, Heat & Power Co.; Mr. Walbank was the successful candidate. The other officers are: Vice-Presidents, Messrs. M. J. Butler, Phelps Johnson and J. S. Dennis; Councilors, Messrs. G. A. Keefer, D. McPherson, G. H. Duggan, C. E. W Dodwell, C. H. Rust, W. McNab, W. F. Tyre, E. V. Johnson, W. H. Breethaupt, J. A. Jamieson, R. S. Lea, R. A. Ross, G. J. Desbarats, John Kennedy, F. P. Gutelius, W. H. Laurie, R. J. Durley, L. G. Papineau, H. Hardman and A. A. Dion.

NEW ENGLAND WATER-WORKS ASSOCIATION.—The February meeting of the association will be held at Hotel Brunswick, Boston, Mass., Feb. 13. Mr. William R. Conrad will read a paper on "Some Observations on Cast-Iron Pipe Specifications," and Mr. William Lyman Underwood will give a lecture.

THE NOVA SCOTIA SOCIETY OF ENGINEERS.—This society was organized at Halifax, N. S., Jan. 22. The object of the society, as stated in the adopted constitution, follows:

The objects of the society are to solidify the engineering profession in Nova Scotia; to investigate the resources of Nova Scotia; to conduct investigations in regard to engineering materials and supplies in Nova Scotia; to raise the standing of the profession; to bring together all branches of the engineering profesion as well as architects, contractors and those interested in engineering.

The membership will be composed of honorary members, members, associates and students, the membership to be drawn from all branches of engineering. Officers will be elected at the next meeting. The temporary President is Prof. Brydone Jack, of Dalhousie University, while Mr. A. R. McCleave is temporary Secretary.

OHIO ENGINEERING SOCIETY.—The 28th annual meeting was held Jan. 22-24, at Columbus, Ohio. The membership of the society has now reached the two hundred mark, having doubled in the past three years. The officers elected for the year 1907 are as follows: President, Mr. A. F. Cole; Vice-President, Mr. Wm. Wilson; Secretary and Treasurer, Mr. E. G. Bradbury; Board of Trustees, Messrs. B. E. Trask, John Laylin, F. E. Meyers, J. H. Asher, and R. E. Kline. The County Surveyors' Section of the society elected Mr. F. M. Kennedy, President and Mr. John Laylin, Secretary, while the Municipal Section elected Mr. R. E. Kline, President; Mr. F. E. Meyers, Vice-President, and Mr. E. A. Kemmler, Secretary. The committee on legislation reported the probable passage of the bill providing for the registration of civil engineers, at the next session of the legislature and recommended an effort to rectify the confused legislation regarding county surveyors and their assistants passed at the last session.

Mr. Kimberly, in his paper on "The Use and Abuse of Sewage Disposal Plants in Ohio," criticised the management of sewage disposal works in the state, and strongly advocated professional supervision of such plants. Prof. Judd's paper on "A Few Remarks on the Pitot Tube and Its Uses," was based principally on original experimental work. He finds the coefficient of the tube to vary from unity by a very small fraction of one per cent, and his investigations indicate that the point may be of almost any size or form without affecting the results, provided the velocity of flow is not interfered with. Numerous other interesting papers were read, those of general interest being "Contracts and Contractors," Mr. F. M. Kennedy; "Compilation and Publication of Property Maps," Mr. F. J. Cellarius; "Fuel Economy and Smoke Abatement," Mr. G. W. C. Lomb; "Present Need of Better Protection for Lessening the Mortality Incident to Travel on Our Railroads," Mr. J. B. Strawn.